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APR 5 1928

The Engineer.

Established 1856. Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

VOL. CXLV.—No. 3767] LONDON: FRIDAY EVENING, MARCH 23, 1928 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Wednesday, 11th April, 1928, for ACCELERATED LOW-PRESSURE HOT WATER HEATING at Fulham Telephone Exchange, S.W.

Drawings, specification, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 8048

The Director-General, India Store Department, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for—

Schedule.
1. About 92 Tons of BRIDGEWORK.
2. About 690 Tons of BRIDGEWORK.

Tenders due on the 20th April, 1928, for No. 1, and on the 4th May, 1928, for No. 2.

Forms of Tender obtainable from the above at a fee (which will not be returned) of 5s. for each schedule. 8083

Air Ministry. DIRECTORATE OF SCIENTIFIC RESEARCH.

A JUNIOR SCIENTIFIC OFFICER is REQUIRED for the Air Ministry Scientific Research Staff, primarily for duty at the Royal Aircraft Establishment for research in applied physics, chiefly in connection with aeronautical instruments.

Candidates should have a first-class Honours Degree in Natural Science or Mechanical Science, and must be medically fit for flying duties and be willing to fly as observer.

Salary £175 plus Civil Service bonus per annum, giving a present total starting remuneration of £265 19s. per annum on the scale £175-£15-£235 plus bonus per annum.

The appointment will carry superannuation under the Federated Universities Superannuation Scheme; Government contribution being 10 per cent. of salary, individual contribution 5 per cent.

Preference given, other things being equal, to an ex-Service man.

Application should be made on a form to be obtained from the CHIEF SUPERINTENDENT, Royal Aircraft Establishment, South Farnborough, Hants, to whom it should be returned, quoting reference No. A265, not later than 13th April, 1928. 8038

Air Ministry. DIRECTORATE OF TECHNICAL DEVELOPMENT.

DRAUGHTSMAN (civilian) REQUIRED. Candidates should have had good technical training, such as apprenticeship at a recognised engineering establishment and a knowledge of elementary mechanics and mathematics. A knowledge of the elements of engineering design is also desirable, and experience in a drawing-office (preferably on aircraft work).

Starting salary up to 52s. a week plus Civil Service bonus (which gives present total 82s. a week) according to qualifications and experience.

Ex-Service man preferred.

Applications, showing qualifications, &c., should be made to the OFFICER COMMANDING, Marine Aircraft Experimental Establishment, Royal Air Force, Felixstowe, Suffolk. 8055

Assistant Engineers (10) REQUIRED by the GOVERNMENT of NIGERIA for the PUBLIC WORKS DEPARTMENT for two tours of not less than 12 nor more than 18 months' service in the first instance. Subject to satisfactory service the officers appointed will be eligible at the expiration of three years' service for confirmation in the permanent and pensionable establishment. Salary £480, rising to £920 a year. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, preferably between 25 and 35 years of age, must have passed the examination for A.M.I.C.E. or possess a degree in civil engineering recognised by the Institution as exempting from Parts "A" and "B" of the examination. Must have had proper technical training and preferably have had not less than two years' subsequent experience on large engineering or municipal works.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting M. 254. 7956

Civil Engineers (2) Required by the GOVERNMENT of SIERRA LEONE for two tours of 12 to 18 months' service, with possible extension. Salary £600 a year, rising by annual increments of £30 to £720 a year. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, aged 30 to 35, must have had experience in Road and Bridge Construction and Road Location Survey, and preferably be corporate members of the Institution of Civil Engineers or hold an Engineering Degree or Diploma recognised as granting exemption from Sections A and B of the A.M.I.C.E. examination.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting M/510. 8074

Safety in Mines Research BOARD. RESEARCH APPOINTMENTS.

The Safety in Mines Research Board REQUIRES TWO JUNIOR ASSISTANTS for Research, one for employment in connexion with colliery wire ropes research and the other for employment on research on materials and structures for the roof support of underground workings. Applicants must possess good scientific qualifications, including a University Degree (or its equivalent) in engineering, have a good knowledge of testing materials, and be good draughtsmen, but special knowledge of metallurgy is not required. Other things being equal, preference will be given to ex-Service candidates.

Scale of salary £160 per annum, rising by annual increments of £10 to £190.

In addition a fluctuating cost-of-living bonus is payable, making the present minimum of the scale £246.

The posts are whole-time ones and tenable in London.

Forms of application, which must be returned not later than 7th April, can be obtained from the UNDER SECRETARY FOR MINES, Establishment Branch, Mines Department, Dean Stanley-street, London, S.W. 1. 8067

The Engineer

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PUBLIC NOTICES

In the Matter of Letters PATENT granted to J. R. C. KEARNS, T. B. BURTON and H. W. KEARNS and CO., Ltd., dated 22nd May, 1912, and numbered 12,122 of 1912, for the invention of and relating to "Improvements in Milling, Facing, Drilling and Boring Machines." NOTICE IS HEREBY GIVEN that on the 24th April, 1928, an ORIGINATING SUMMONS (taken out on behalf of the above-named Patentees) asking that the term of the Patent may be extended for five years, will come before Mr. Justice Tomlin in the Chancery Division of the High Court of Justice for directions, and any person desirous of being heard in opposition must at least seven days before that date lodge Notice of Opposition at Room 175, Royal Courts of Justice, Strand, London, and serve a copy thereof upon the undermentioned Solicitor.

Dated 19th March, 1928.

GEORGE BELOE ELLIS,
8058 70 and 72, Chancery-lane, London, W.C. 2.

Borough of Stockton-on-Tees.

The Council are prepared to receive TENDERS for the SINKING of FOUR TUBED BORE-HOLES, 60ft.-70ft. each in depth, through clay and other material into solid rock on the site of the proposed new quay wall. Conditions of contract, specification and form of Tender can be obtained from me on payment of a deposit of £1, which will be refunded upon receipt of a bona fide Tender and the return of the documents.

Sealed Tenders, marked "Tender for Borings," to be delivered to me not later than Saturday, 7th April, 1928.

All further information may be obtained on application to the Borough Engineer, Victoria Buildings, Stockton-on-Tees; or to Wm. Muirhead, M. Inst. C.E., 6, Queen Anne's-gate, London, S.W. 1.

No obligation hereby devolves on the Council to accept the lowest or any Tender received.

THOS. DOWNEY,
Town Clerk.

Borough Hall,
Stockton-on-Tees,
19th March, 1928. P4323

PUBLIC NOTICES

Eastry Rural District Council. AYLESHAM DRAINAGE. TO CONTRACTORS.

The Eastry Rural District Council are prepared to receive TENDERS for the CONSTRUCTION of CAST IRON SEWERS of 15in., 16in., and 21in. diameter for a total length of about 6200 Yards, together with MANHOLES. Also TANKS, FILTER BEDS, SLUDGE DRYING BEDS, FENCING and other Works, in accordance with the plans and specification prepared by the Engineers, Messrs. John Taylor and Sons, Caxton House, Westminster, S.W. 1.

Copies of the specification, bill of quantities and form of Tender may be obtained from, and drawings may be seen, at the offices of the Engineers, upon payment of £5 (cheque only), which will be returned upon receipt of a bona fide Tender.

Sealed Tenders, endorsed "Aylesham Drainage, Contract No. 2," addressed to the undersigned at the Council Offices, 51, Strand-street, Sandwich, Kent, must be received before Noon on Tuesday, the 3rd day of April, 1928.

The Council does not bind itself to accept the lowest or any Tender.

By Order,
(Sgd.) FRED. A. CLOKE,
Clerk to the Council.

Council Offices,
51, Strand-street, Sandwich, Kent. 8040

Rochford Union. LANCASHIRE BOILER, STEEL CHIMNEY, &c. &c.

The Guardians of the Rochford Union invite TENDERS for the SUPPLY, DELIVERY, and ERECTION of ONE LANCASHIRE TYPE BOILER, STEEL CHIMNEY, PIPE WORK, &c. &c.

Specification and form of Tender may be had on application to the Guardians' Consulting Engineer, Mr. H. Tomlinson-Lee, M.I.E.E., 26, Victoria-street, Westminster, S.W. 1, on payment of a fee of Two Guineas.

Tenders, endorsed "Rochford Union, Tender for Boiler, Chimney, &c. &c." and addressed to the undersigned, must be delivered not later than 10 a.m. on Monday, April 16th, 1928.

The person or firm whose Tender is accepted will be required to enter into a contract and to obtain a policy of guarantee (to be issued by a society approved by the Guardians) for the due performance of the work. In sending their names to the Engineer two references as to recent work carried out must be given.

The Guardians do not bind themselves to accept the lowest or any Tender.

By Order,
W. HARDING ROBERTS,
Clerk.

27, Victoria-avenue, Southend-on-Sea. 8043

PUBLIC NOTICES

Alton Urban District Council. WATERWORKS. SERVICE RESERVOIR AND MAIN.

The Council are prepared to receive TENDERS for the CONSTRUCTION of a REINFORCED CONCRETE COVERED SERVICE RESERVOIR and the LAYING of a 9in. MAIN, &c., in accordance with specifications and drawings prepared by their Consulting Engineers, Messrs. H. Rofe and Son, MM. Inst. C.E., 208, Abbey House, Victoria-street, Westminster, S.W. 1.

The drawings may be seen and a copy of the specification and form of Tender, with schedule of quantities, may be obtained on and after Monday, the 26th inst., at the offices of the Consulting Engineers upon the payment (by cheque only) of the sum of Five Guineas, which will be returned after the receipt of a bona fide Tender.

Tenders to be sent to the undersigned on or before Twelve o'clock Noon of Wednesday, the 11th April, 1928, endorsed "Tender for Reservoir and Main."

The acceptance of a Tender will be subject to the approval of the Ministry of Health, and the Council do not bind themselves to accept the lowest or any Tender.

W. BRADLEY TRIMMER,
Clerk to the Council.

The Town Hall, Alton, Hants,
15th March, 1928. 8046

Metropolitan Water Board. TENDERS FOR THE SUPPLY OF STORES, &c.

The Metropolitan Water Board invite TENDERS for the SUPPLY of the undermentioned STORES and SERVICES, &c., for the periods of 6 and 12 months, commencing 1st June, 1928:—

Tender No.
1. Bricks, Fire-bricks, Cement, &c.
8. Iron and Steel.
9. Bolts and Nuts, Screws, Files, Shovels, Steam Tubes, &c.
12. Fuel Oil, Oils (Lubricating), Kerosene, Motor Spirit, Greases, Tallow, &c.
19. Iron, Brass, Gun-metal, and other Castings.
20. G.M. Stop Cocks and Ferrules, Outlets and Caps for Fire Hydrants.
22. Timber.
23. Maintenance of Weighing Machines.

Tenders must be submitted on the official forms, which may be obtained from the Chief Engineer, by personal application at the offices of the Board (Room 136) or upon forwarding a stamped addressed brief envelope.

Applicants should refer to the number of the Tender for which forms are required.

Tenders, enclosed in sealed envelopes, addressed to "The Clerk of the Board" and endorsed in the manner indicated in the form of Tender, must be delivered at the offices of the Board (Room 122) not later than 11 a.m. on Friday, 20th April, 1928.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Roseberry-avenue, E.C. 1,
21st March, 1928. 8066

Shanghai Municipal Electricity DEPARTMENT. STAFF APPOINTMENT. CHIEF ASSISTANT ENGINEER.

The Electricity Department of the Council begs to thank those gentlemen who recently applied for the POSITION of CHIEF ASSISTANT ENGINEER, but regrets that with two exceptions applicants did not fulfil the conditions mentioned in the notification of the 17th February last.

The undersigned is now authorised to offer a salary for the above appointment for the first three years of Taels 1500 per month, which, together with the amount added in the Superannuation Fund, brings the salary up to approximately £2500 per annum.

It is essential that applicants must either hold now or recently have held office as Deputy Chief Engineer or similar position in an Electricity Supply Undertaking, preferably in a large one.

It is desirable that candidates should not be over 40 years of age, but a slight extension of the age limit might be made if considered advisable.

The appointment holds out good prospects for promotion to the position of Deputy Engineer-in-Chief and Manager.

First-class passage out and home, also for wife if applicant is married.

Free medical attention and participation in Superannuation Fund and Pension Scheme.

It should be noted that residents in Shanghai are exempt from British income tax on their salaries.

Applications should be submitted in writing (only), giving full particulars regarding age, education, training, subsequent experience and present position held, and forwarded to the undersigned, c/o Messrs. Preece, Cardew and Rider, 8, Queen Anne's-gate, London, S.W. 1, not later than Saturday, 31st March, 1928. Envelopes should be endorsed "Chief Assistant Engineer."

T. H. U. ALDRIDGE,
M.I.E.E., M.I. Mech. E., Fel. A.I.E.E.,
Engineer-in-Chief and Manager.

22nd March, 1928. 8049

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PUBLIC NOTICES

The Mid-Sussex Joint Water Board.

The Mid-Sussex Joint Water Board invite PROPOSALS for a SCHEME to ELIMINATE MANGANESE and IRON from the DEEP WELL WATER at their Balcombe Works, together with a TENDER for the necessary PLANT. The Plant to be capable of dealing with 21,000 gallons of water per hour and to render it suitable for drinking and general domestic purposes.

Full particulars and copies of the analysis of the water can be obtained at the office of the Engineer, Boltro-road, Haywards Heath.

Tenders will be considered only from firms who specialise in this class of work.

The Board do not bind themselves to accept the lowest or any Tender nor to reimburse any firm for any expense they may incur in preparing Schemes and Tenders.

Sealed Tenders, endorsed "Balcombe Water," are to be addressed to the Clerk to the Mid-Sussex Joint Water Board at his office in Boltro-road, Haywards Heath, and to be delivered not later than 10 a.m. on Monday, the 2nd day of April, 1928.

FRANCIS MARTIN, M.I. Mech. E.,
Engineer.

Waterworks Office,
Haywards Heath,
19th March, 1928. 8054

Belfast Harbour.

The Belfast Harbour Commissioners REQUIRE a fully qualified person for the POSITION of ASSISTANT to the SUPERINTENDENT of CRANES, FERRY BOATS and WEIGHBRIDGES. Salary according to qualifications. Age not exceeding 40 years.

Applicants must have sound commercial experience, in addition to which knowledge of Electrical and Mechanical Engineering is desirable.

Applications, giving full particulars of training, qualifications and experience, and accompanied by copies of not more than three recent testimonials, must be sent, on or before Thursday, the 5th April, 1928, to the undersigned, endorsed "Assistant Superintendent of Cranes."

M. J. WATKINS,
General Manager and Secretary.

Harbour Office, Belfast,
16th March, 1928. 8041

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, GENTLEMAN (ENGINEER), with good business experience, for the Management of a newly established Company (London) having a virtual monopoly in the engineering branch. Capable interviewer and able to obtain business. Partnership desirable, but not essential. Gentleman with knowledge of French and German preferred.—Address in confidence, stating full details of experience, age, &c., P4311, The Engineer Office. P4311 A

WANTED, High-class EXECUTIVE, with Practical experience of Tools and Methods, required for mass production of light machinery. Good salary to right man.—Address reply to "EXECUTIVE," Wm. Porteous and Co., Advertising Agents, Glasgow. P4308 A

WANTED, Smart ASSISTANT to ADMINISTRATIVE INDUSTRIAL ENGINEER; must have some Administrative Commercial Knowledge, and experience in the Running of a Fleet of Heavy Motor Lorries. Age 25 to 30.—Address, 8079, The Engineer Office. 8079 A

WANTED, Thoroughly Competent DESIGNER, accustomed to Road Rollers, Traction Engines, &c., for works near London. Only experienced men need apply. State age, experience, and salary required. —Address, 8065, The Engineer Office. 8065 A

A WORKS MANAGER REQUIRED for Small Factory in Midlands, preferably with experience in Spinning of Metals and kindred trades. Must be good organiser with initiative and capable of handling labour.—Address full particulars, age, experience, and salary expected, which will be treated in confidence, P4303, The Engineer Office. P4303 A

ASSISTANT ENGINEER REQUIRED for Sales Department, preferably having some experience in Application of Ball and Roller Bearings. Age about 25.—Box D, 3, Old Jewry, London, E.C. 2. 8069 A

CONSULTING CIVIL ENGINEER in Westminster REQUIRES ENGINEERING ASSISTANT with good general experience. Knowledge of Reinforced Concrete essential and must be good Draughtsman and Surveyor.

Address applications, stating age, experience, and salary required, with copies of two recent testimonials and particulars of engineering qualifications, &c., 8062, The Engineer Office. 8062 A

ENGINEER REQUIRED for East Africa for Erection of Steel Buildings, Heavy Oil Engines, and Decorticating Plant with native labour, and subsequently undertake running and maintenance.—Address, stating age and salary required, P4316, The Engineer Office. P4316 A

ENGINEER, Young and Energetic, with Theoretical knowledge and experience Mechanical Engineering, including D.O., good memory and visibility, WANTED for Manufacturing and Contracting Business where problems have to be dealt with promptly not always on orthodox lines. Pay and prospects according to ability. State age, training, experience, &c.—Address, 8084, The Engineer Office. 8084 A

ENGINEERING ASSISTANT to WORKS MANAGER WANTED by Glasgow Firm doing fine work of highest class. Graduate with practical experience of accurate Fitting and Machine Work, about 25 years of age, wanted.—Address, stating age, training, and salary expected, 7996, The Engineer Office. 7996 A

FULLY Trained WORKS ENGINEER REQUIRED in North Midlands, to Take Charge of Maintenance, Repair and Construction Work in a Large General Steel Works, comprising Acid and Electric Melting Furnaces, Foundry, Forge, Machine Shops, Electric Sub-stations, &c.

Applicants must be not less than 35 years of age. Several years' previous experience as a plant and maintenance engineer is essential.

State fully, in confidence, particulars of training, previous experience, age, and salary required.

Address, 8024, The Engineer Office. 8024 A

GENTLEMAN, with Engineering or Drawing-office experience, REQUIRED as London Representative of Company producing Non-ferrous Alloys in all forms.—State all details, age, experience, &c., to BM/YTOO, London, W.C. 8039 A

OIL-BURNING EQUIPMENT SPECIALISTS IN LONDON REQUIRE ADDITIONAL TRAINED ENGINEERS with commercial experience for Co-operation with Sales Staff.—Address, 8061, The Engineer Office. 8061 A

QUALIFIED ENGINEER (26) DESIRES APPOINTMENT as Works Manager or Assistant General Manager of progressive concern; 10 years' comprehensive experience in hydraulics, internal combustion and general engineering. Highest references.—Address, P4305, The Engineer Office. P4305 B

REQUIRED by Firm of Gearing Specialists Having headquarters in London, young ENGINEER-SALESMAN, to travel throughout the country.—Write, giving full details as to age, experience, education and salary required, to Box 122, c/o Mather and Crowther, Ltd., 10/13, New Bridge-street, E.C. 4. 8051 A

SALESMAN (Part Salary and Commission) WANTED by City House for Woodworking Machines. Must have sound connection amongst users. State age, experience, and remuneration required.—Address, 8042, The Engineer Office. 8042 A

SITUATIONS OPEN (continued)

SALESMAN REQUIRED for Diesel Engines: First-class connection and experience.—PORN and DUNWOODY, Limited, "Chronicle" House, 78, Fleet-street, E.C. 4. 8052 A

REPRESENTATIVE REQUIRED for London and district by well-known makers of Boiler and Evaporator Accessories. Must have practical experience of steam raising, in addition to being of approved selling ability.—Address, P4330, The Engineer Office. P4330 A

STRAITS SETTLEMENTS.—WANTED, Qualified CIVIL ENGINEER, preference Public School education, Scotsman, unmarried, age about 30, with Constructional and Outside Work Experience. Good salary and prospects to capable man.—Write, with full particulars of experience, &c., to Z.Y. 426, c.o. Deacon's Advertising Agency, Fenchurch-avenue, London, E.C. 3. 8071 A

WORKS MANAGER REQUIRED by a British Firm in India for their Bridge, Constructional Steel and General Engineering Works. Good salary offered for a thoroughly competent and qualified engineer. Age 30 to 40.—Write, Z.H. 414, c.o. Deacon's Advertising Agency, Fenchurch-avenue, E.C. 3 8073 A

WANTED IMMEDIATELY by a Firm Manufacturing Electric Cranes in the Manchester district, competent DRAUGHTSMAN. Give full particulars and salary required.—Address, 8045, The Engineer Office. 8045 A

DRAUGHTSMAN, Also JUNIOR, REQUIRED, for General Engineering or High-speed Oil Engines; 30 miles from London. State age, experience and salary required.—Address, 8068, The Engineer Office. 8068 A

DRAUGHTSMAN, Experienced in Reinforced Concrete Work, REQUIRED by Specialist Firm. One with some Architectural training preferred.—Apply by letter, stating age and salary required, to K. HOLST and CO., 1, Victoria-street, S.W., 1. P4321 A

DRAUGHTSMAN (JUNIOR) REQUIRED, Experience in Steel-frame Buildings; works, Slough. Experience and salary expected.—Address, P4325, The Engineer Office. P4325 A

DRAUGHTSMAN, Quick, Accurate, Good Calculator, used to Furnace Applications, WANTED AT ONCE for Combustion Engineers' Office; none but experienced men need apply. State age, salary required and when at liberty.—Address, P4318, The Engineer Office. P4318 A

DRAUGHTSMEN WANTED, South of England, for Handling Contracts in Material Handling Plants. Experienced mechanical and structural men only need apply.—Write age, full experience and salary required, Box 80, Sell's, Fleet-street, E.C. 4. 8057 A

DRAUGHTSMAN, with First-class Experience of Steam Turbine Design and Detail Work, for works in Midlands. State age, salary, experience, and when able to commence.—Address, 7930, The Engineer Office. 7930 A

JIG and TOOL DRAUGHTSMAN, with Good general experience, REQUIRED IMMEDIATELY, for London district. Must be an accurate and reliable worker. Permanency to a suitable man.—Address, stating age and salary required, 8078, The Engineer Office. 8078 A

LEADING MECHANICAL DRAUGHTSMAN WANTED, experienced on Ships' Deck Machinery, Windlass, Capstans, Steering Gears. Must be able to design, estimate and carry through the details.—Address, stating experience, age, and salary expected and when able to commence, 8064, The Engineer Office. 8064 A

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Limited, Trafford Park, Manchester, REQUIRES DRAUGHTSMEN with experience in Steam Turbine Details.—Applications, giving particulars of age, experience, and salary required, to be addressed to the COMPANY'S EMPLOYMENT DEPARTMENT, marked "Turbine Draughtsmen." 8050 A

SEVERAL Competent DRAUGHTSMEN REQUIRED IMMEDIATELY, with Boiler-house experience, preferably furnace work.—Apply by letter, stating age and salary required, to COMBUSTION ENGINEERING, Ltd., Derby. 7943 A

TEMPORARY CIVIL ENGINEERING DRAUGHTSMAN REQUIRED, with knowledge of Sea Works, Masonry, Steel Work, and Ferro-concrete Building Construction. Quick and neat draughtsmanship absolutely essential, and selected applicants will be subject to test. Age 23-28. Salary £4 per week.—Address, stating age, qualification, experience, and with copies of two testimonials, 8082, The Engineer Office. 8082 A

ENGINEER WORKING FOREMAN WANTED for General Works, provincial district, about 20 hands. One used to Traction and Portable Engines, Repairs, Pumps and Agricultural Work; knowledge of drawing essential. Age 30 to 35. Two copies recent references. State salary if good house free.—Address, 8050, The Engineer Office. 8050 A

REQUIRED by a European Firm of Structural and General Engineers in India, an ASSISTANT FOREMAN in their Structural Department. Applicants must have experience in Template Making and be accustomed to Bridge, Roof and General Structural Work; must be a bachelor and not more than 26 years of age.—Apply, stating age and full particulars of experience, to Z.Z. 427, care Deacon's Advertising Agency, Fenchurch-avenue, E.C. 3. 8072 A

SITUATIONS WANTED

A FULLY TRAINED MECHANICAL and CIVIL ENGINEER (36) DESIRES APPOINTMENT; 20 years' experience in shops and D.O. as works and field engineer and in commercial and administrative positions. Last appointment five years as chief assistant engineer and buyer to an oil company.—Reply to F., 35, The Avenue, Sunbury-on-Thames. P4315 B

A QUALIFIED ENGINEER (41), Experienced home and foreign railways, tramways, automobile, steam, I.C. engines, foundry and constructional works, sound sales, purchasing and factory organiser, ex-chief D.O. and manager 1000 men, SEEKS CHANGE.—Address, P4225, The Engineer Office. P4225 B

ADVERTISER, Educated, with Long Practical Experience of modern engineering and foundry methods, DESIRES CHANGE, managerial capacity.—Address, P4320, The Engineer Office. P4320 B

BOILERMAKER, General All-round Practical and technical man, with sound experience of locomotive boilers and boilers of all types, able to design and construct boilers of any class, and accustomed to general repairs to the existing ones throughout; having also extensive experience of general constructional work, tanks of every description and well advanced with general engineering work; has been employed on large railways in India, Persia and South America, now employed with the Chinese Government Railways employed as boiler shop foreman and chief boiler inspector, taking charge of over 1000 Chinese workmen, will be disengaged in November and DESIRES POST in any part of the globe. Highest references; single man, age 38, and enjoys splendid health.—Address, P4310, The Engineer Office. P4310 B

ENGINEER (Commercial) DESIRES SITUATION as Purchasing or Sales Manager in old-established Shipping House or good Firm; 30 years' experience, excellent character, well known, with established connection.—Address, 8080, The Engineer Office. 8080 B

ENGINEER (25) REQUIRES SITUATION; Technical training (passed A.M.I. Mech. E. exam.), 5 years' workshop experience.—Address, P4329, The Engineer Office. P4329 B

SITUATIONS WANTED (continued)

ENGINEER (31), Apprenticeship and College Training, works and sales experience, DESIRES POSITION as Assistant to General Manager or as Sales Representative.—Address, P4327, The Engineer Office. P4327 B

MECHANICAL ENGINEER (22) WISHES POSITION as a Junior Draughtsman; 2 years D.O., 4 years workshop; marine and cold-starting oil engine experience, technical college training. Excellent references.—Address, P4322, The Engineer Office. P4322 B

MARINE ENGINEER (36), 1st Class Board of Trade Certificate, 12 years' sea experience, SEEKS SITUATION ashore. Excellent references.—Address, P4328, The Engineer Office. P4328 B

STOREKEEPER WANTS CHANGE, 150 to 200 men, extensive experience; £100 cash security.—Address, P4313, The Engineer Office. P4313 B

YOUNG ENGINEER, G.I. Mech. E., Ex Public school, 21 years of age, First Class Board of Trade Certificate and mechanical engineering diploma, REQUIRES POSITION, Junior Assistant, Inspectorship, or Maintenance.—Address, P4319, The Engineer Office. P4319 B

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For continuation of For Sale Advertisements see page 3.

A Seven-Day Journal

A Large Order for Water Turbines.

WE are informed that the "Kraftwerk Ryburg-Schworstadt A.-G.," of Rheinfelden, has placed an order for four water turbines which will form the equipment of the Ryburg-Schworstadt hydro-electric power plant, now under construction on the Rhine, with the "Arbeitsgemeinschaft Turbinenbau Ryburg-Schworstadt," a combine specially formed for the purpose of this contract by the three firms, Ateliers de Charmilles, Geneva; Escher Wyss et Cie., Zurich and Strassburg; J. M. Voith, Heidenheim, a.d. Brenz. These three firms will handle the contract together, so as to comply with the terms of the concession, according to which approximately half the plant is to be manufactured in Germany and the other half in Switzerland. This condition led to the formation of the above mentioned working combine. The three firms will have approximately an equal share in the work, all the units having to be, in accordance with the terms, of exactly the same design. The turbines are of the Kaplan type—that is, they will be equipped with movable runner-vanes—and they are, we understand, the largest turbines of this type now under construction. They will have vertical shafts and will be built-in in concrete spiral casings. Each turbine will be capable of developing an output of 39,500 H.P. under a net head of 11·5 m. when running at a speed of 75 r.p.m. The specific output of the turbines, that is the output brought to 1 m. head, is 1000 H.P., whereas the largest Kaplan turbines now in operation—the turbines of the Swedish power plant "Lilla Edet"—have a specific output of only 675 H.P. To enable an idea of the dimensions of the Schworstadt turbines to be formed, it may be said that the runner-wheels will have an external diameter of 23ft., and that the height of the guide vanes will be 8ft. 6in. The main contractor for the whole plant is the "A.-G. Motor Columbus," of Baden, Switzerland, which firm is also responsible for the planning of the scheme.

Wages in the Engineering and Shipbuilding Trades.

ON Thursday of last week, March 15th, a conference took place in London between representatives of the trade unions connected with the engineering industry and the Engineering Employers' Federation, when the application of the unions for an advance in wages on a national basis of 8s. a week, with a corresponding increase in piece work prices, was discussed. There was a large attendance, the trade unions being represented by 94 delegates from thirty-four unions, while the employers' representatives numbered about 100. The case for the unions was based on the trade returns and unemployment figures—which were held to show that the engineering industry was improving month by month—and was put by Mr. J. T. Brownlie, who was supported by Mr. John Hill and Mr. W. Sherwood. Sir Allan Smith, who replied on behalf of the employers, stated that it was not possible to give at that meeting a definite answer to the claim presented for an advance, as the employers were bound to consult their local associations with regard to the matter. At some length Sir Allan went on to consider the question of the burden of rates and taxes on the industry, and spoke of the efforts which the employers had made, as yet with little success, to get the Government to deal with this matter and to institute through the Ministry of Labour an inquiry into the real nature of the unemployment problem, including the proportion among the unemployed of skilled, semi-skilled and unskilled men. At a conference of the craft unions of the shipbuilding industry, which was held in London on Friday of last week, March 16th, it was unanimously decided that the offer of a 3s. advance to time workers in the shipbuilding industry under certain conditions, made by the Shipbuilding Employers' Federation, was unsatisfactory in its present form, and it was resolved to request the Federation to arrange a further conference.

Pulverised Fuel for Ships.

IN the course of a speech delivered at the recent annual dinner of Old Time Marine Engineers, held in New York, Mr. Carl J. Jefferson, of the Fuel Conservation Committee of the United States Shipping Board, made some interesting references to the immediate future prospects for pulverised fuel in American ships. Speaking of the powdered fuel installation in the cargo vessel "Mercer," which was described in THE ENGINEER of December 16th last, Mr. Jefferson stated that the reliability and safety of pulverised fuel had been clearly demonstrated, and that the "Mercer" had maintained her sailing schedule in the North Atlantic trade as satisfactorily and with greater economy than had her sister ships burning oil or hand-fired coal. The same speed had been made by the "Mercer" with two boilers burning pulverised fuel as with three boilers fired by coal or oil in the ordinary manner on sister ships. Mr. Jefferson went on to say that plans and specifications were now being prepared for the equipment of a further six cargo ships with pulverised fuel plant. He considered that the trade route upon which a ship was called to operate was a deciding factor in the choice of the best type of propelling machinery. Thus from the American point of view, said Mr. Jefferson, vessels trading to South American ports and to the Far East by way of the Panama Canal had the advantage of cheap oil. The bunker coal, especially in South American ports, was costly and often of inferior grade, and hence oil-burning ships, preferably motor vessels, were advantageous on these routes. For the Atlantic trade, the Atlantic Coastal trade and that of the Great Lakes, along with the West and South African trades, Mr. Jefferson saw a distinct economic advantage in the use of pulverised coal. Moreover, in converting existing ships, the installation of pulverised fuel plant was not, he said, handicapped by the excessive first cost charges which had been incurred in some recent conversions of steam to motor vessels carried out in America.

The New Power Station at Coventry.

DURING the past few months the construction of the new Coventry power station at Longford has made rapid strides, and a few days ago Alderman M. K. Pridmore, Chairman of the Electricity Committee, laid a corner stone in the structure, and unveiled a tablet recording the names of the members of the Electricity Committee holding office at the time the erection of the new station was begun. The station will play an important part in the Electricity Commissioners' scheme for Central England, which has just been submitted to the Central Electricity Board. The contract for the work is in the hands of the British Thomson-Houston Company, and, including the feeder cables and sub-station equipment, it will cost approximately three-quarters of a million pounds. Each of the 18,750-kilowatt B.T.H. turbo-generator sets will run at 3000 revolutions per minute, and generate three-phase, 50-cycle current at a pressure of 6600 volts, which will be raised to 33,000 volts for transmission to the sub-stations. The transformers will be placed in the open at a spot adjacent to the switchgear annexe of the turbine-room. Each boiler will be capable of producing 60,000 lb. of steam per hour at a pressure of 325 lb. per square inch. It is said that the new station will compare favourably with any other station that has been erected, and that for its output its cost is low.

The Loss of the U.S. Submarine S 4.

THE United States submarine "S 4," which was rammed by the coastguard destroyer "Paulding," and sunk in 100ft. of water off Provincetown, Massachusetts, on December 17th, was on Saturday of last week, March 17th, brought to the surface by the naval salvage fleet, and was dry-docked two days later at Boston. On inspecting the interior of the hull it was found that the hole in the inner shell was only about a foot wide and 30in. long, and in it part of the bow of the "Paulding" was still wedged. There could not have been any great rush of water through the hole, it is thought, and it is considered by the investigators that after the collision "S 4" could still have remained afloat if it had been only possible to continue to man the controls in the control room. For some reason, probably, it is thought, owing to fumes from fused cables, the men were driven from the control room into the torpedo room, where five or six bodies were found. The emergency supply of oxygen in the torpedo room was not entirely exhausted, but in the engine room, where thirty-four bodies were found, the oxygen supply was probably used up in a little more than a day. Everything within the submarine is covered with mud and oil, and it is hoped that when this coating has been removed, some further light may be thrown on the possible cause of the disaster. Meanwhile, it is announced that President Coolidge has recommended Congress to put aside the sum of £40,000 for investigations and experiments on safety devices for submarines. If practical safety devices are found, they will be fitted on all the submarines in the United States Navy.

Cables and Wireless.

DETAILS are now available concerning the terms under which the fusion of the interests of the Eastern and Associated Telegraph Companies and Marconi's Wireless Telegraph Company is to be brought about. A holding company with a capital of £53,700,000 is to be formed. This company will acquire all the ordinary, preference and debenture capital of the Marconi Company and the whole of the ordinary share capitals of the cable companies, but will leave the cable companies' preference and debenture stock undisturbed. The share capital in the holding company will be allocated in the proportion of £36,350,000 to the cable companies and £17,350,000 to the Marconi Company. The voting power in the new company will be divided in the proportion of 56¼ per cent. to the shareholders in the cable companies and 43¾ per cent. to the Marconi company's shareholders. Twelve members of the board of the holding company will be nominated by the cable companies and eight by the Marconi Company. The fusion has been inspired by the rapid development of beam wireless and by the prospect which that development foreshadowed of a severe conflict for traffic between the cable and the wireless companies. Already the news of the projected fusion has created considerable apprehension in some quarters, particularly in India, for it is feared that it may result in the public, the Press and the trading community being deprived of the reduced charges and increased efficiency promised by the development of beam wireless telegraphy. The fusion agreement is subject to satisfactory arrangements being made with the British, Dominion and Indian Governments.

Royal Opening of the Science Museum.

THE Eastern Block of the new Science Museum, South Kensington, was opened by their Majesties the King and Queen on Tuesday, the 20th inst. In declaring the new buildings open, the King said that he and the Queen took very great interest in the National Museums that have been developed on the South Kensington site, and were happy to be associated with this memorable event in the history of science and of engineering. He referred to the work done by his grandfather, the Prince Consort, in acquiring the estate on which these institutions now stand, and in fostering their growth. The Science Museum would attract not only the student, but also the public interested in the development of our material civilisation. After the speech, their Majesties made a tour of the galleries, and their attention was especially arrested by the fine collection of ships of all periods and of all nations that has just been placed in these new quarters, which now are open to the public.

A British Electrical Engineering Corporation.

AT the annual general meeting of the Metropolitan-Vickers Electrical Company, Ltd., held on Friday of last week, March 16th, it was officially intimated that Vickers Ltd. had sold its control of the company, and that that control now lay in the hands of Mr. F. Dudley Docker. The history of the company is interesting. In 1918 it was known as the British Westinghouse Company, and was controlled by the American Westinghouse Company. In that year Mr. F. Dudley Docker, of the Metropolitan Carriage, Waggon and Finance Company, bought it from the American Westinghouse Company. Very shortly afterwards Vickers Ltd. purchased the Metropolitan Carriage Company, and thereby acquired control of the electrical company, which thereupon became known as the Metropolitan-Vickers Electrical Company. Quite recently, Vickers Ltd. sold its interests in the company to the International General Electric Company, and subsequently Mr. Docker, returning to the industry again, acquired control of the undertaking. Behind the new control there is apparently the intention to form in Great Britain "an electrical engineering corporation resting on sound foundations and so organised that it can compare favourably with the undertakings in Germany and America." These are the words used by Sir Philip Nash, the chairman of the company, at the annual meeting in describing what was required to provide a permanent solution of the troubles and difficulties surrounding the industry. Sir Philip explained that the formation of a consolidated electrical undertaking was one of the objects which Mr. Docker had in view when he purchased the British Westinghouse Company in 1918. On the board of the Metropolitan-Vickers Company Mr. Docker will be represented by his son, Mr. Bernard D. F. Docker, whose appointment as a director and deputy chairman was confirmed at the meeting last week.

The Institute of Transport Dinner.

THE eighth annual dinner of the Institute of Transport was held at the Hotel Cecil on Wednesday evening last. The chair was taken by Mr. Roger T. Smith, the President, and among those present were Lord Darynton, Mr. E. C. Trench (President of the Institution of Civil Engineers), and Mr. Archibald Page (President of the Institution of Electrical Engineers). In proposing the toast of the evening, Lord Darynton referred to the great change made in transport, and said that it was nothing to what was to come. People, thanks to transport, were no longer satisfied with what they used to have, but wanted the best transport could give. Lord Darynton claimed that he had one particular qualification in proposing that toast, in that he was, when in the House of Commons, the representative of the birthplace of railways. Mr. Roger Smith, in replying, alluded to the many phases of transport, and said that they wanted transport by air to be better represented in its activities. That would probably be furthered by the fact that, at its last meeting, the Council of the Institute had nominated Sir Sefton Brancker as the next President. Mr. Roger Smith added that it was hoped that shipping people would become more interested in the Institute. Sir Henry Maybury, in proposing the toast of "The Guests," said that it was transport that won the war. Major Sir Archibald Boyd Carpenter and Mr. Trench—the President, as Sir Henry Maybury said, of the greatest technical institution in the world, which this year celebrated its centenary—responded.

The Static Balancing of Rotors.

By Professor B. P. HAIGH, D.Sc., Royal Naval College, Greenwich.

No. I.

THE balancing of rotors, like many other branches of engineering, comprises two parts—the theoretical science and the practical art of the subject. The theoretical principles of balancing have long been firmly established on the basis of Newton's laws of motion and probably no longer admit of any important development. On the other hand, the practical art of balancing changes from year to year, and varies according to the character of the rotor and the requirements of the circumstances in which it will be used.

Thirty years ago the art of balancing was a part of the greater art of design, and its chief field of application was in the drawing-offices of firms building reciprocating engines for high piston speeds. The masses of the revolving and reciprocating parts were adjusted "on paper" by means of calculations, such as those so clearly presented in Professor Dalby's classical work on the subject; and as the masses were seldom readjusted after an engine had been constructed, it may be said that the art of balancing was not then practised in the shops.

The advent of the steam turbine and of other high-speed rotating machinery changed this situation greatly. As such machines are usually inherently balanced "on paper," higher speeds of rotation were adopted, and, as a consequence, a new art of balancing became necessary to eliminate the effects of minor imperfections of material or of workmanship. The field for this new art—developed by the managers and staffs of engineering firms and by others who have introduced machines specially designed to facilitate accurate balancing—lies clearly in the workshops and not in the drawing-offices of the industry.

In different engineering works, engaged in the construction of different kinds of machinery, widely different methods of balancing have been developed with success. It is the object of these articles to indicate why such different methods are preferred in different circumstances, and to contrast the advantages of static and dynamic balancing.

To appreciate the advantages of the methods in general use, it is doubtless desirable to adopt the standpoint of the long-established theoretical principles. Only from this standpoint does it seem possible clearly to understand what is accomplished and what is left unaccomplished by the use of different types of balancing machines, or to appreciate the effect of different imperfections of balance in different circumstances.

It is often said that there are two distinct kinds of balance and unbalance—"static" and "dynamic"; but it should be added that these are the two types of "external balance," and that the whole idea of external balance is based on a hypothetical conception—on the hypothesis that the rotor may be regarded as a rigid body incapable of flexure. In many problems, the elastic flexure of the shaft is a matter of primary importance; and in some cases the state of internal balance or unbalance has considerable influence on the resulting motions and loads.

The distinctions between different types of unbalance are contrasted in Fig. 1, in which—for the sake of clearness only—it is assumed that all the masses lie in one plane, that of the paper.

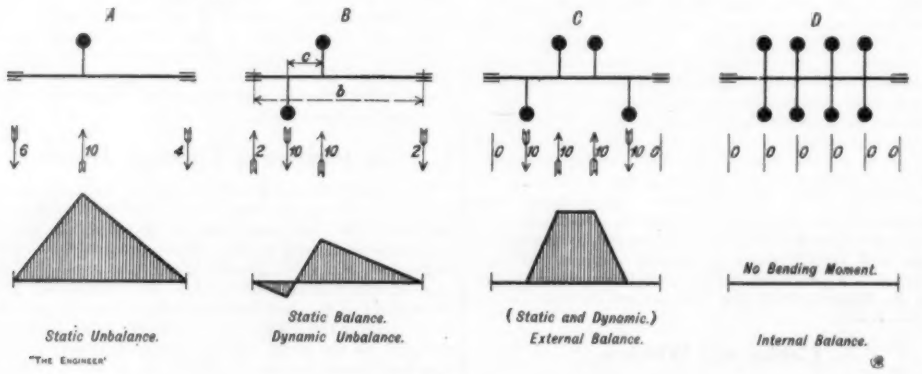


FIG. 1

Shaft A, carrying only a single mass m at radius r, is statically unbalanced. To produce the centripetal acceleration of the mass the bearings apply two "external" forces to the shaft. These forces act in the same direction and add together to give the total centripetal force $F = \omega^2 m r$.

Shaft B, carrying two masses m on equal but opposite radii, is statically balanced but dynamically unbalanced. Since the two centripetal forces act in different planes of rotation, separated by a distance c, the bearings have to apply forces to produce a couple $\omega^2 m r c$. To do this they apply two equal but opposite forces, viz., $\omega^2 m r c/b$, where b is the distance between the two bearings.

Shaft C, with two pairs of masses similar to those of shaft B, is balanced dynamically as well as statically as regards the "external" actions of the bearings. Since the couples required for the two pairs of masses balance one another, the bearings contribute no external forces to produce the accelerations and carry only the steady weight of the rotor.

Shaft D, with masses arranged in pairs in each plane of rotation, is also balanced in this external sense, but differs in respect that it is "internally" balanced. Since the masses in each individual plane of rotation are in static balance, no forces have to be transmitted along the shaft as shear stresses. The shaft is therefore free from the bending-moments that are represented below the diagrams for cases A, B and C.

The contrast between cases C and D illustrates how

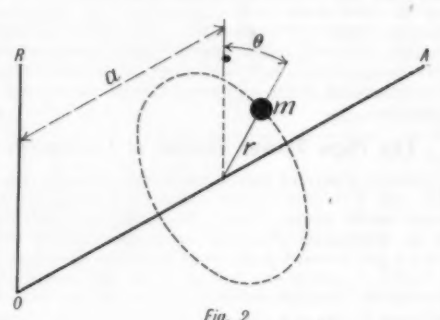


Fig. 2

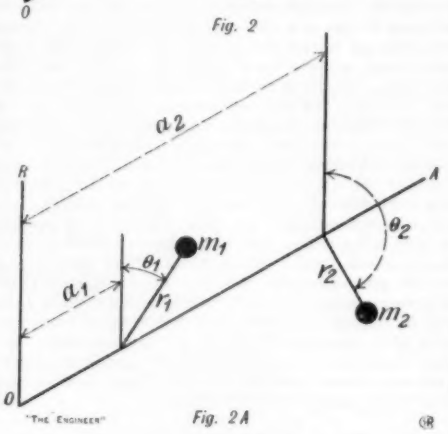


Fig. 2A

FIGS. 2 AND 2A

shafts that are completely balanced, statically and dynamically, as regards external action, may nevertheless be subject to heavy shear stresses and bending moments—and may therefore flex under centripetal action. It is largely with the object of eliminating this flexure that the shafts of six-cylinder petrol motors are often fitted with as many as seven bearings. Although such motors are dynamically balanced for primary and secondary forces and couples, their shafts would flex unduly under the bending moments that would act if fewer bearings were used.

An internally balanced rotor may be defined as one in which the masses in each individual plane of rotation are statically balanced. Internal balance represents the highest attainable ideal in balancing and is necessary, probably, only in exceptional circumstances—for example, in the case of slow-speed steam turbines with large numbers of separate impulse wheels on a relatively thin shaft. Internal balance is attained by balancing the shaft statically in several successive stages, first with one or two wheels in place, and then with more and more until all are assembled. After each operation, any excess metal is removed from the wheels of the group that was added immediately before that operation.

In other circumstances, when flexure is less important, internal balance may be unnecessary. The relative importance of static and dynamic balance then varies in different cases according to the very different external effects that may be produced in different circumstances by the two kinds of unbalance.

The conditions for external balance, without reference to internal, are readily expressed mathematically in four equations, two of which relate to static balance and two to dynamic. In Fig. 2, let O A represent the axis of rotation, and O R any line scribed radially on the rotor, so that R O A constitutes a radial plane of reference fixed relatively to the rotor. Let m denote any mass element at distance a from the plane of rotation that passes through the origin O and at radius r in the direction that makes an angle θ to the reference plane R O A. Then the components of static unbalance are—

$$\Sigma (m r \cos \theta) \text{ and } \Sigma (m r \sin \theta),$$

while the components of dynamic unbalance, relatively to the origin O, are—

$$\Sigma (m r a \cos \theta) \text{ and } \Sigma (m r a \sin \theta).$$

The rotor is externally balanced if all four terms are zero.

If the four terms are not zero, the rotor can be balanced by adding any combination of masses such that the revised values of the four terms become zero. A fundamental principle shows that any rotor can be balanced by adding only two masses, at given radii r_1 and r_2 in different planes, with distances a_1 and a_2; and that the four simultaneous equations provide a means of finding the four unknown quantities, viz.:—

$$m_1,\ m_2,\ \theta_1 \text{ and } \theta_2\text{—see Fig. 2A.}$$

In drawing-office practice the art of balancing consists of two distinct steps:—(1) Finding by calculation the values of the four components of unbalance, and (2) solving, after having chosen the most convenient values of a_1, a_2, r_1 and r_2, the four simultaneous equations that give the requisite values of m_1, m_2, θ_1 and θ_2. The procedure is purely mathematical, and lends itself to the use of a variety of elegant graphical constructions that appeal to the eye and often assist the choice between different values of the distances a_1 and a_2.

In workshop practice likewise, if balancing machines were able to measure and indicate the values of the four components of unbalance in the rotor tested, the additional masses and their positions could be calculated by algebra or by graphical constructions or even by means of a simple mechanism that would replace the purely mathematical steps in the task. But, unfortunately, the experimental measurement of the four components presents certain difficulties; and as a consequence, workshop practice commonly falls back on slow expedients in which patience and skill replace, with more or less success, the definite processes of mathematics.

As regards the first two terms—for static balance—definite measurements are readily made by means of the Martin balancing machine. The greater difficulty lies in the determination of the components of dynamic unbalance; and it is here that workshop methods most commonly fall back on slow expedients of a "hit-or-miss" character.

The task of a balancing operator endeavouring to attain dynamic balance is enormously simplified if the rotor has already been brought to static balance in an accurate degree. Instead of having to juggle with four independently variable quantities, he now has to keep only two separate variables in mind, and this task is within the bounds of reasonable skill. For this reason, it appears sound practice to organise workshop balancing in two distinct stages, static and dynamic, so that the much more difficult operation of dynamic balancing may be as successful as possible.

If this plan be adopted, however, in order to lighten the task of the second stage, it is important that the rotor should really be in static balance when it is delivered from the first stage to the second. If the operator in the second stage is misled in believing that the rotor is already in static balance, he has but little chance of success. To attempt to solve a problem involving four variables, and to do so in the belief that only two are involved, is to attempt what is almost impossible unless the operator is assisted by mere chance. For this reason, as well as others, it is important that static balancing should be carried out in the most accurate way that may be possible—with definite measurements of the components of unbalance, followed by the addition of exactly appropriate masses in the correct positions.

In some dynamic balancing machines an attempt is made to measure the components of dynamic unbalance after the components of static unbalance have been initially measured and corrected; and in others, all four components are measured before any additional masses are attached to the rotor. Such machines, however, are necessarily complex in their design and are subject to the disadvantage that the rotor has to be mounted in a massive rigid frame that oscillates about an axis that should be held in a fixed position. In the simpler types of dynamic balancing machine, intended for use after the rotor has been balanced statically, no such oscillating frame is necessary, as the two bearings can be mounted on independent springs to allow of the necessary oscillation in a definite plane.

The organisation of balancing in two distinct stages is advantageous, not merely because it facilitates the attainment of the best possible results when such results are required, but also because rotors may be divided into two main groups—those in which dynamic balance is really desirable, and those in which dynamic balancing is an unnecessary refine-

ment. The second group is, in fact, much the larger. It appears desirable that all important rotors should be balanced statically, and that only a few should go on to the more expensive second stage of dynamic balancing. The utility of this basis of division is more apparent when we reflect that very great advantages are gained at small expense by static balancing, and that the advantage gained at great expense by dynamic balancing is often only very slight indeed.

The practical importance of static balancing is largely due to the way in which any initial eccentricity of the rotor is magnified by the elastic flexure of its shaft. To avoid undue magnification, it is a common practice to design shafts so that the "primary" critical whirling speed lies at least 20 per cent. above the highest running speed; but a smaller margin may suffice if the rotor is well balanced, and a larger margin may be necessary if the state of static balance is unsatisfactory.

As the effects of static and dynamic unbalance are distinctly different in this respect, it may be desirable, first, briefly, to state the now well-known action of static unbalance, and then proceed to consider dynamic unbalance by contrast.

If a certain rotor—Fig. 3—of mass M could be brought to static balance by the addition of a mass m at radius r, the initial excentricity of its centre of gravity is $e = m \cdot r/M$. But when the rotor runs its shaft flexes under the bending moments associated with the centrifugal force, and the centre of gravity revolves in a circle whose radius may be larger than e. If the shaft flexes a distance x, the radius of excentricity becomes—very approximately—the algebraic sum of e and x.

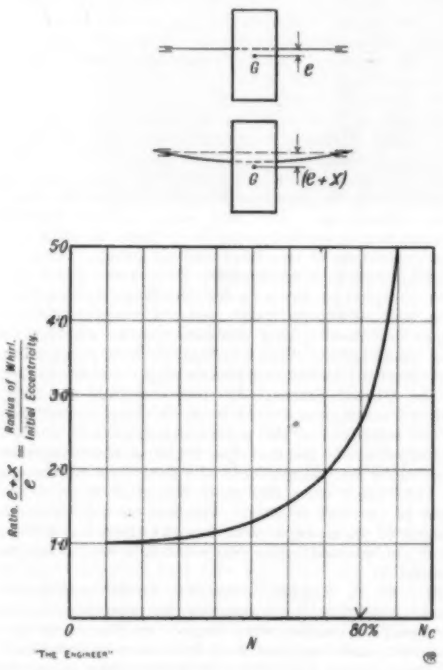


FIG. 3

The relation between x and e is given by the equation

$$x = e/[(N_c/N)^2 - 1],$$

where N_c denotes the critical whirling speed and N is the running speed. Fig. 3 shows how any initial excentricity e is magnified at any particular speed. The ordinates give the ratio between the sum $e + x$ and the initial e, while the abscissæ give the ratio between N and N_c. At the critical whirling speed, when $N = N_c$, the ratio of magnification given by this simple formula becomes infinite—which means to say, that the merest trace of initial excentricity then suffices to maintain great whirling motion. To this conclusion must be added two limitations:—(1) The influence of friction may limit the whirling that can be maintained, although seldom to a safe value; and (2) although a trace of excentricity may maintain dangerous vibration when such vibration has been produced, a considerable time may be required to produce it if the shaft is not otherwise disturbed. For these reasons, it is not generally unsafe to run through the critical speed if a shaft is well balanced statically.

Fig. 4 serves to indicate how the centrifugal loads on the bearings depend on the ratio between the running speed and the critical. The sum of the two loads is given by—

$$\Sigma\,(F) = \left(4\,\pi^2\,W\,e/g\right)\left[\frac{1}{N^2} - \frac{1}{N_c^2}\right]$$

where N and N_c are measured in revolutions per unit time, and W is the weight of the rotor, the initial excentricity of which is again denoted by e. Graphs are plotted for different values of e in the ratio 10 : 1 : 1/10; and a horizontal line is drawn to indicate—arbitrarily—a maximum total force that may be tolerable in some particular case. For example, if one unit of excentricity is tolerable up to 90 per cent. of the critical speed, ten units are tolerable only up to some 55 per cent. If the excentricity is reduced by more ideal balancing to only $^1/_{10}$ unit, the force still reaches the limit of toleration at 98 per cent. of the critical. Such considerations indicate that the customary 20 per cent. margin between the running speed and the critical is required to cover not only any uncertainty in the calculation of the true critical speed, but also an allowance for imperfections of balancing.

To illustrate the remarkable contrast between the whirling actions produced by dynamic and by static unbalance, consider the particular case of the rotors shown in Fig. 5, A and B. Let it be assumed, hypothetically, that the two rotors are homogeneous and

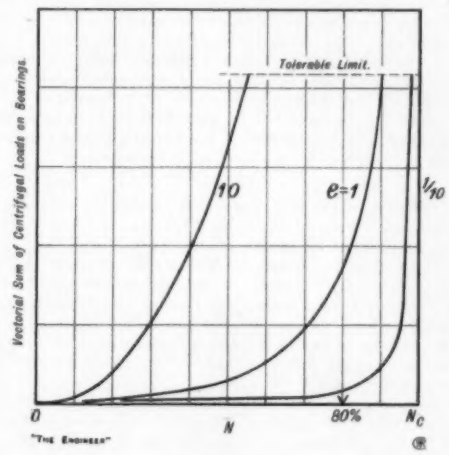


FIG. 4

truly cylindrical, and that they are in perfect balance statically. They are, of course, dynamically unbalanced because—and only because—the bored holes that fit the shaft are inclined at a small angle e to the normal of the plane faces. This inclination may be regarded as the "angle of excentricity" in dynamic balance, comparable with the linear excentricity that characterises static unbalance. The two rotors contrasted may be described as a disc and a long cylinder. Let it be assumed that the values of the moments of inertia about the axes of symmetry are denoted in either case by I, and that J signifies the value of the moment of inertia about the perpendicular axes through the centre of gravity. In the disc I is greater than J—nearly twice as great—whereas in the long cylinder J is greater than I. This difference accounts for a notable difference in behaviour.

When either body rotates, its shaft flexes under

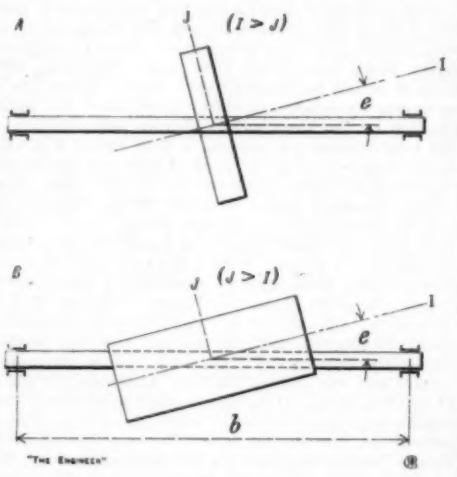


FIG. 5

the action of dynamic unbalance, and the axis of symmetry moves round the surface of a cone whose angle θ differs from the initial angle of excentricity e. To keep the rotor moving in this manner, a couple must be applied by the bearings and transmitted through the shaft to produce the radial accelerations of the component masses, and the value of this couple is given by a well-known theorem in rigid dynamics—

$$C = \tfrac{1}{2}\,\omega^2\,(J - I)\sin 2\,\theta,$$

where $\omega = 2\,\pi\,N$ is the angular velocity of rotation. As θ is but a small angle—hypothetically, in the practical cases in question—it will suffice to adopt an approximation, viz.:—

$$C = \omega^2\,(J - I)\,\theta.$$

This couple can be expressed also in terms of the stiffness of the shaft and the angle $(\theta - e)$ of flexure under the bending moments. In the case considered, let it be assumed that the stiffness of the shaft against lateral bending is such that a force F, applied laterally through the centre of gravity, would deflect it through a distance $x = F/S$. The "stiffness" for bending under the couple of dynamic unbalance can then be readily deduced to be—

$$\frac{\text{Change of couple applied}}{\text{Change of angle of flexure}} = \frac{b^2\,S}{4}$$

where b denotes the distance between the two symmetrical bearings. The couple required to bend the shaft through the angle $\theta - e$ is then given by—

$$C = \tfrac{1}{4}\,b^2\,S\,(\theta - e).$$

The equation between the two above values for the couple is—

$$\tfrac{1}{4}\,b^2\,S\,(\theta - e) = \omega^2\,(J - I)\,\theta.$$

When this equation is rearranged, it yields an expression for the ratio between θ, the angle of excentricity when running, and e the initial angle. Thus—

$$\frac{\theta}{e} = 1 \Big/ \left(1 - \frac{4\,\omega^2\,(J - I)}{b^2\,S}\right)$$

The character of this solution varies according as J is greater or less than I, and the graphs shown in Fig. 6 serve to contrast the two cases.

When I is the greater, as in the disc wheel A, the ratio θ/e decreases continuously as the speeds rise; and there is no sign of any "critical" whirling speed other than the ordinary "primary" action already described. The shaft bends a little, so that the plane faces of the disc gradually become more and more nearly perpendicular to the axis of rotation—the line that joins the bearing centres—and the angle θ gradually dies away from its initial value e to zero. The action is not unlike that observed when a rotor with static unbalance runs *above* its critical speed; and it may be said that the whirling speed for the disc with dynamic unbalance is in the mathematical sense "unreal or imaginary."

Actually, there is no higher critical speed for dynamic unbalance in the case of thin wheels with I greater than J. The action is fairly comparable with that of the inclined disc used in many speed indicators, and in some governors. As the speed rises, the disc or ring swings about its pivots against the couple exerted by a spring, and gradually approaches the plane perpendicular to the axis.

In the case of the long cylinder, with J greater than

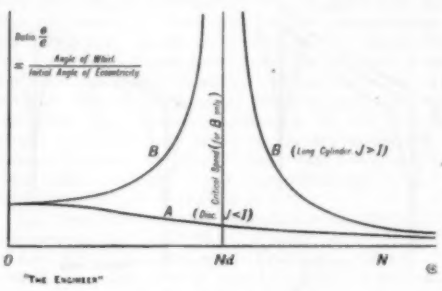


FIG. 6

I, the action is more like that observed with static unbalance, but the value of the critical speed is higher. The critical speed for dynamic unbalance is given by the formula

$$4\,\omega_d^2\,(J - I)/b^2 S = \text{unity},$$

$$i.e.,\ \omega_d^2 = b^2\,S/4\,(J - I).$$

It is instructive to compare the value of this latter critical speed with the better known "static" critical value. To do this, let J and I be replaced by the terms $m\,k_j^2$ and $m\,k_i^2$ in which k_j and k_i signify the "radii of gyration" about the axes of J and I. Then—

$$\omega_d^2 = \frac{b^2\,S}{4\,m\,.\,(k_j^2 - k_i^2)} = \frac{b^2\,\omega_e^2}{4\,(k_j^2 - k_i^2)}$$

where ω_e is the statical critical speed. Hence—

$$\frac{\omega_d}{\omega_e} = \frac{\text{Dynamic critical speed}}{\text{Static critical speed}} = \frac{b}{2\sqrt{k_j^2 - k_i^2}}$$

In any ordinary rotor this ratio is always much greater than unity; and it follows that the whirling speed at which dynamic unbalance first makes itself really evident always lies far above the better-known critical speed at which static unbalance produces dangerous effects although dynamic unbalance does not.

In the case of rotors that have to run at 70 to 80 per cent. of the well-known critical speed, it follows that static unbalance is liable to be magnified while dynamic unbalance is not. Great care should be taken to eliminate static unbalance from such rotors, but dynamic unbalance may often be disregarded.

In several types of dynamic balancing machine, an oscillation comparable with whirling is produced by mounting the bearings of the rotor as in Fig. 7, in such a manner that motion occurs in the horizontal plane, but not in the vertical. In the diagram, the bearings are fastened to the tops of flat springs that are firmly fixed at their lower ends to a massive bedplate.

A rotor constrained in this manner oscillates at two distinct critical speeds, which, of course, are both much lower than the working critical speed of the shaft in bearings supported in a more rigid manner. As represented in smaller sketches in the diagram, the

two springs move to and fro together in the primary mode of oscillation ; while in the secondary mode they move in opposite directions in see-saw manner. Oscillation in the primary mode is provoked by static unbalance, but not by dynamic ; and oscillation in the secondary mode is provoked by dynamic unbalance but not by static. To make use of such a machine to study dynamic unbalance, it is necessary to run through the lower primary critical speed up to the secondary ; and if the two critical speeds are nearly alike, it is particularly difficult to interpret the actions observed, because the two effects then intermingle. In any case, of course, it is desirable to eliminate the static unbalance before starting to use the machine, and the rotor will then run up quietly through the first critical speed and oscillate only when it reaches the second.

The ratio between the two critical speeds in such a machine, in which the rotor oscillates in plane motion instead of whirling in conical, is not the same as in the true conical whirling motion studied above ; and the action does not depend on the ordinary moment of inertia I but only on the transverse moment J. Thus

$$\frac{\text{Secondary (or dynamic) critical speed}}{\text{Primary (or static) critical speed}} = \frac{b}{2\,k_j}$$

where k_j, as before, denotes the radius of gyration

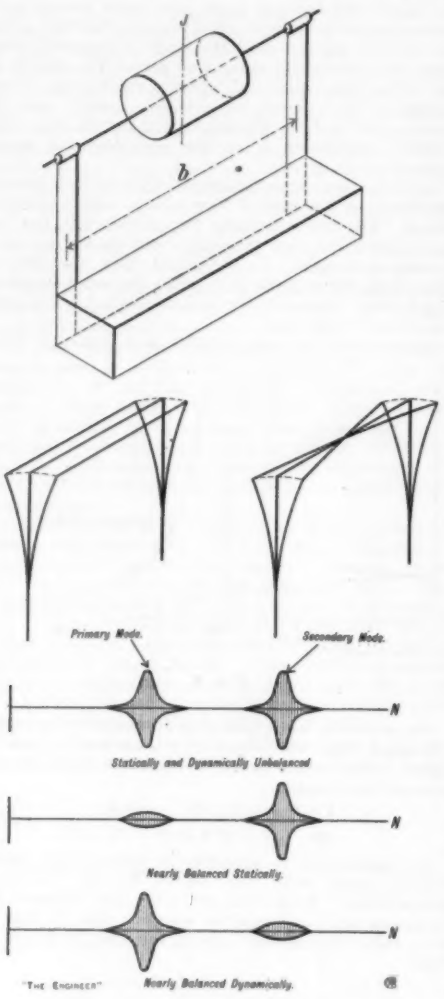


FIG. 7

about the transverse axis. As k_j is almost necessarily less than $\frac{1}{2}\,b$, where b is the distance between the springs, it follows that the speed at which dynamic unbalance makes itself evident is higher than the primary critical at which the static action predominates. When the two speeds are sufficiently different, the records obtained are as indicated in Fig. 7, in which three sketches record the amplitude of oscillation on a base that represents the speed of rotation.

It is notable that dynamic unbalance shows itself much more evidently in such a machine than in the whirling motion already studied as being typical of practical conditions. In such a machine, in which the shaft oscillates in plane motion, there is always a secondary critical speed—no matter what may be the relative value of I and J—and this speed is usually not very far above the primary. In conical whirling, such as occurs in practice, the secondary critical speed is, as has been shown above, absent or very much higher than the primary. The conditions in the balancing machine are therefore artificial, and intentionally such as to exaggerate the importance of any dynamic unbalance. The observer should not carry away the impression that both actions necessarily occur at correspondingly higher speeds in practice.

(To be continued.)

Institution of Mechanical Engineers.

JUST before the meeting of the Institution of Mechanical Engineers in London on Friday of last week, March 16th, an interesting ceremony was held in the basement of the Institution buildings. Some time ago the railwaymen of the Argentine Republic presented to the Institution a large and handsome wall plaque, designed by an Argentine sculptor and cast in an Argentine foundry, taking the form of a memorial to George Stephenson, the Institution's first President. The memorial was inspired by appreciation of what railways and the railway locomotive have done for the Republic. The first Argentine railway, it may be remarked, was built in 1857, and to-day there are 45,000 kiloms. of line in existence. On Friday of last week the memorial was unveiled by the Argentine Ambassador, his Excellency Señor Don J. Evaristo Uriburu. Simultaneously, his Excellency presented to the Institution a memorial shield on behalf of the Argentine Society of Inventors. The ceremony was attended by the Dean of Westminster, the Mayor of Westminster, the President and Council and a considerable number of the members.

Subsequently, the members assembled to hear a paper by Captain H. P. M. Beames, entitled "The Reorganisation of Crewe Locomotive Works."

Before calling upon the author, Mr. Richard Allen, who was very cordially received, expressed to the members his deep regret that, owing to illness he was unable to be present at the preceding meeting and assured them, on taking the presidential chair for the first time, that he would serve the Institution to the best of his ability.

Following a few words of an appreciative and humorous kind from the Mayor of Westminster—an engineer who deserted our profession for the Bar—Sir John A. F. Aspinall opened the discussion. Sir John recalled that in his younger days at Crewe in the early 'seventies he was in charge of the building of a number of the shops shown in Captain Beames' first plan—Fig. 1 of the paper. Mr. Webb was the locomotive superintendent at the time, and under his care the Crewe shops were regarded as the best and most up-to-date of their period. Time had, however, shown that increased facilities were required for dealing with the augmented size and number of locomotives owned by the company. The rebuilding and extension of the shops described by Captain Beames had proved most satisfactory. The work had well repaid the capital expended on it, and had, in fact, saved more than had been expected of it. Some people imagined that the object of a railway company's works was to build new locomotives. That was not so. The duty of such works was, day in, day out, to repair the existing stock of engines, a work on which, without proper organisation and care, a great deal of money could be thrown away. To carry it out efficiently, it was necessary to have a large number of parts ready for use, and having these parts it was a mere nothing to build a few new engines each year. The L.M.S. railway now owned 10,000 locomotives, each of which it might be assumed passed through the repair shops once every two years—that was, 5000 engines would be repaired each year. If the life of an engine were taken at thirty-three years, the maintenance of the fleet would require the building of 333 new engines per annum, a task which was very small compared with the work of taking to pieces and reassembling 5000 locomotives in the same time. Captain Beames' paper revealed the fact that Crewe still required a good locomotive testing plant. Surely with a fleet of 10,000 engines, it would be worth while having such a plant. With a trained staff, it would enable many factors to be determined which could not be obtained from road tests. On the L.M.S. railway the annual cost of repairs to locomotives was about £5,000,000, and the annual fuel bill reached almost the same figure. On the L.N.E.R. the annual repairs and the annual fuel bill amounted to about £4,000,000 each. If by any testing appliances these tremendous figures could be reduced, even by a small percentage, the saving would be very considerable. To the railway engineer the locomotive testing plant was as necessary as the stethoscope was to the doctor.

Mr. Francis Carnegie said the paper would have had added advantage if figures had been given for the saving effected by the reorganisation. How many years, he asked, would it take to recover the capital expended on the reorganisation, due allowance being made for the increased overhead charges, depreciation, and so forth, caused by the reorganisation ? He was surprised to learn that the works now obtained the required supply of electricity from the North Wales Power Supply Company, and that no attempt was made to generate it on the site. In addition to the possibly cheaper production attending local generation, the steam required for heating and any process work would be obtained at a reduced cost. Dealing with the construction of new boilers at Crewe, and the author's statement that the men engaged on the work were kept in one position, the boilers being moved from stage to stage, he asked whether the boilers were mounted on trolleys. He was doubtful of the advantage of moving the boilers rather than the men, for men were much more mobile than boilers. He observed that the shafting for such machine tools as were not independently motor driven had been fitted throughout with ball bearings. His experience was that ball bearings for shafting showed an increased efficiency of about 30 per cent. over plain bearings, and that in a new works it paid to install ball bearings. But in an old works did it pay to take out the plain bearings and substitute ball bearings, which cost at least twice as much ? In addition to the cost of installation, the change-over required a fairly long stoppage of the shafting and the machines. In that connection he called attention to the economy of time that would be effected if ball or roller bearings could be obtained in the split form. Captain Beames had stated that the floor of the new erecting shop at Crewe was constructed of wooden blocks with concrete paths for electric trucks where necessary. Why had concrete been used for the paths ? Was it because of cost, ease of running or reduction of wear on the floors ? His experience with concrete paths was that under heavy loads they sometimes flaked or broke up. He noticed that the heating of the erecting shop was carried out on the overhead system, the steam pipes being placed above the bottom ties of the roof principals. Had floor-level heating been considered ? He found that with the overhead system 75 per cent. of the heating effect was lost. In an actual instance, he said, it had been found that to heat to 55 deg. with an external temperature of 32 deg. floor level heating required 30 per cent. less steam than the overhead system. Dealing with the "belt" system of repairs, Captain Beames had said that the component parts had to be delivered in time to be put in before the next move had proved a powerful incentive to every shop in the works. But things did not always work to a time limit. There might be a bad casting or work might be accidentally spoilt. What happened in such an event ? Was the prearranged time for the moves adhered to ?

Sir Henry Fowler said that the paper covered a large subject in a small space. It was necessary for the railways to become more and more efficient in the matter of repairing their locomotive stock. Crewe was not alone in being cramped for extension, and it was therefore essential that all the works should study efficiency. The new shops which Captain Beames had described broke away from the old Crewe type consisting of two bays and an arcade. The new erecting shop had considerable floor space, apart from that occupied by the pits, but the floor, in spite of its area, was not allowed to be used as a store for material. There had been a long discussion as to whether the new erecting shop should be laid out with longitudinal pits or with pits running crosswise, as was the custom in the United States. He believed that the longitudinal arrangement was best, because it lent itself to the adoption of the processing system of working described in the paper. The result of the reorganisation could be judged from the fact that at the end of 1927 there were 500 more locomotives in service than at the end of 1926. The key to success in the system of repairing now in use at Crewe was to have what you wanted, when you wanted it, and where you wanted it.

Mr. F. A. Lemon, assistant works manager at Crewe, said that the success of the processing system of repairs depended very largely on the goodwill of the men, and they had been fortunate in securing it. At first the men had been a little perturbed as to what effect the new system would have on their earnings, but experience had removed their fears, and as the system became fully operative it had been found possible considerably to increase the men's earnings. The output of repaired locomotives had been improved to such an extent that there had been a reduction in the number of engines standing for repairs down to 7·02 per cent. of the total fleet, as compared with 13·2 per cent. before the reorganisation. The moral effect of the clock was very important. No man throughout the shops cared to incur the responsibility for holding up the "belt."

Mr. F. E. Robinson desired to have further particulars concerning the jigs for erecting the frame plates shown in Fig. 5 of the paper, and asked what effect wear and tear of the jigs would cause. He exhibited a slide illustrating, and described a method of devising, a processing system based on the use of small-scale models of machines cast in lead and of squared paper on which they were laid out.

Colonel Kitson Clark asked the author to tell him what arrangements were made for weighing the engines before they were sent out, how he disposed of his turnings and cuttings, what provision was made for painting the glass roofs of the shops in summer, what provision was made for the men's coats and clothes, and what was the length of travel of the engine details through the shops.

Mr. S. J. Symes, works manager, L.M.S. Derby Works, said that the system of progressing the work on a time basis described by Captain Beames was characteristic of modern practice. Much the same system had been adopted by Mr. Paget at the Derby works twenty years ago. The output of repaired locomotives had been fixed at about twenty per week, and if it were not realised, full explanation had to be rendered. The present Derby system was a modification of Mr. Paget's. Under it the number of engines in the shops undergoing repairs at any one time had been reduced to thirty-nine, as compared with sixty formerly. The weekly output of repaired engines was

THE CEDARS RAPIDS POWER STATION ON THE ST. LAWRENCE RIVER

now twenty-four, when all the bays engaged on the work were fully employed.

Mr. R. E. F. Maunsell asked for information concerning the manner in which the parts stripped from an engine were collected and distributed to the shops for repairs, and how the departmental foremen were told when the parts were wanted back on the "belt." The boilers apparently were always taken out of the frames, although in his experience their removal was not always necessary. Again, time was allowed for such items as taking out the drag boxes, welding the frames, removing the liners and other work which could not be described as essential features of every general repair. If some of these items were not required, how were the stages into which the work was divided balanced and how was the time allotted to the work which was not done filled in? In some cases more time than was allotted would be required, as, for instance, when an engine required to be fitted with new cylinders. How was this extra time provided? The boiler was undoubtedly the chief source of trouble in locomotive repair work. It might require new tubes, new tube plates, new wrapper plates, and so forth. Could it be guaranteed that these repairs would always be completed in the four days alloted to them? He did not think that 6 per cent. of spare boilers would meet the requirements of the situation.

Captain Beames was unable to reply to the discussion owing to lack of time.

Hydraulic Power Developments in Quebec.

WATER-POWER resources in the Province of Quebec are destined to play an incalculably important part in the great industrial development which is now assured for this section of Canada. The total available water-power resources of Quebec is estimated to be 8,459,000 horse-power under conditions of ordinary minimum flow, or 13,064,000 horse-power ordinarily available for six months of the year. These totals include the figures of energy available at sites which have been developed and at which installations of 2,165,443 H.P. have been made. With the general relationship existing between installation and available resources, this development represents probably about 13 per cent. of the total resources of the province.

The St. Lawrence is the outstanding power river with from 2 to 2½ million horse-power available in the reach extending from the Ontario boundary to the harbour of Montreal. This power is capable of economic development in two concentrated reaches, the first embracing the Coteau, Cedars and Cascades rapids between Lake St. Louis and La Prairie basin above Montreal. These resources, so far, have been utilised to a comparatively small extent, involving a total installation of only 275,000 H.P. at the Cedars and Lachine rapids, and along the Soulanges and Lachine canals. The Cedars Rapids station, which belongs to the Montreal Light, Heat and Power Consolidated and has an installed capacity of 197,400 H.P., is shown on the accompanying bird's-eye view. A move is on foot at present to develop 500,000 H.P. in the reach between Lake St. Francis and Lake St. Louis. The project has strong financial backing, and as soon as permission has been granted by the Federal and Quebec governments the work will be commenced.

The Ottawa River and its Quebec tributaries provide power possibilities of from 1,000,000 to 1,600,000 horse-power. On the reach of the Ottawa from Lake Temiskaming to Pointe Fortune, which forms the boundary between Ontario and Quebec, there is a number of large and important power sites, which are shared by the two provinces, and which total from 570,000 H.P. to 950,000 H.P. Above Lake Temiskaming on the Upper Ottawa, and on the part known as the Quinze River, there are powers totalling 90,000 H.P. to 220,000 H.P.

Among the tributaries of the Ottawa River the Gatineau is outstanding, with continuous power possibilities in excess of 400,000 H.P. It is on this river that the Gatineau Power Company is carrying out its huge power development project. Two plants were built last year, one at Chelsea and the other at Farmers Rapids. At the Chelsea plant three 34,000 H.P. units have been installed. Provision has been made for two further units, which will give the plant a total capacity of 170,000 H.P. At the Farmers Rapids development three 24,000 H.P. units were brought into operation last year, and provision has been made for the addition of two further units which will give the plant an ultimate capacity of 120,000 H.P. About 27 miles above Chelsea the company vigorously carried forward the construction of a third plant at Paugan Falls. There, six units each of 24,000 H.P. capacity, are being installed and are expected to be ready for operation in September this year. A fourth plant, at Nigger Rapids on the same river, is contemplated for future development by the company when load conditions warrant. For the benefit of all these plants, the Mercier Dam, creating a very extensive storage reservoir of 95 thousand million cubic feet on the Gatineau, was also completed and filled early last year.

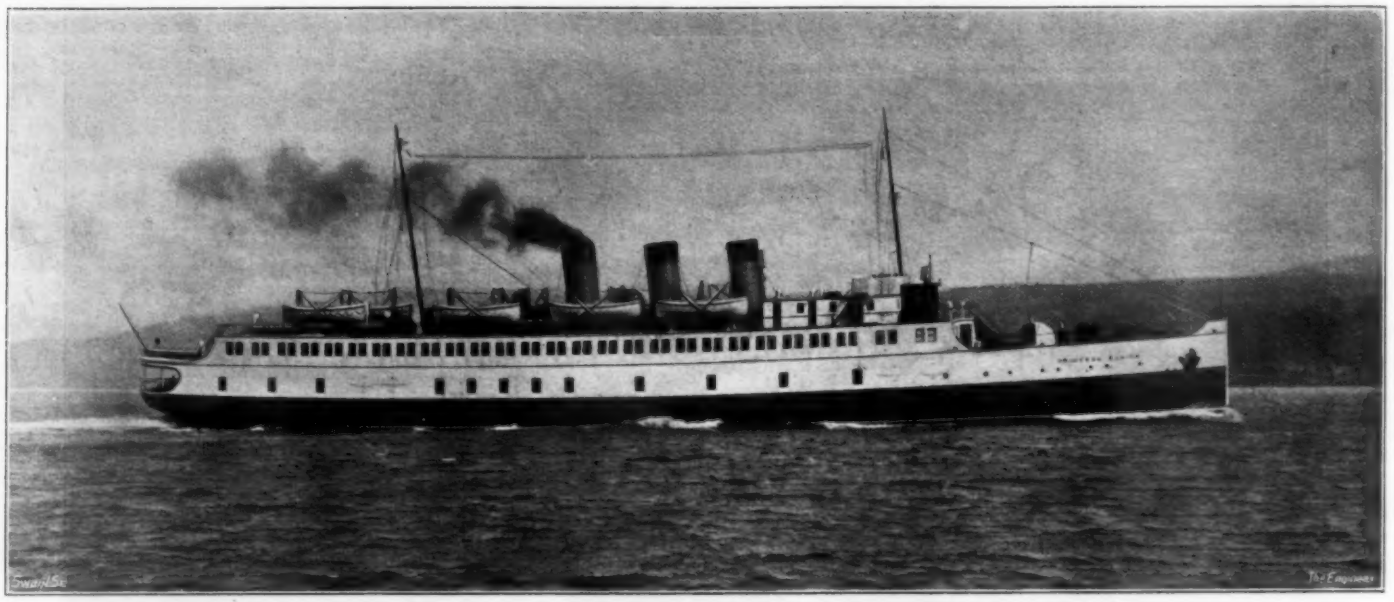
The Saguenay is outstanding among the power rivers of Quebec, and, with its immediate tributaries and rivers entering Lake St. John, has total resources of from 1,260,000 H.P. to 1,530,000 H.P. On the Saguenay there is a descent of 300ft. from Lake St. John to Chicoutimi which may be utilised in two huge power concentrations. The upper of two sites at Isle Maligne has a head of 100ft., and is now fully developed, while the lower, or Chute-à-Caron, site is under construction. These two sites will ultimately have a total installation of 1,340,000 H.P. Tributary to the Saguenay itself, the most important rivers are the Chicoutimi and Au Sable, which are largely developed, and the Shipshaw, having total resources of 88,000 H.P., with two sites utilised and a number still awaiting development. Fig. 1, page 322, shows the spillway at Chute-aux-Galets power-house on the Shipshaw. In the northerly part of Quebec there are many large rivers flowing into James Bay, Hudson Bay and the North Atlantic. These rivers have their courses frequently broken with rapids and falls, but only approximate estimates of the potential power available may be made, as stream records are almost entirely lacking. Such estimates as have been made indicate that the resources are from 1,500,000 H.P. to 3,500,000 H.P.

The total water power installation in the province amounts to 2,165,443 H.P., a figure larger than that of any other province in the Dominion. Most of the power plant installed is found in stations generating electrical energy for general distribution, but a considerable total is also accounted for in developments directly connected with the pulp and paper industry. The production of ground wood pulp and newsprint being the great power-consuming factors in the pulp and paper industry, the statement that the mills of Quebec produce over 52 per cent. of the ground wood pulp and over 44 per cent. of the newsprint manufactured in Canada during 1926, predicates an enormous use of hydraulic power. Hydraulic turbines of an aggregate capacity of 242,044 H.P. are installed in connection with the mills, while an amount—estimated to be in excess of 600,000 H.P.—is purchased from central electric stations. Of the power installed by the mills, 147,266 H.P. is direct-connected to mill equipment and 94,778 H.P. to electric generators. The total utilisation of hydro-electric power by the mills is thus in the neighbourhood of 700,000 H.P.

While the actual development of water-power resources is left to individual enterprise in the province the Government has taken action to assure the conservation of power, and to that end has established the Quebec Streams Commission. This Commission, in addition to basic investigations which are carried out in co-operation with the Dominion Water Power Branch of the Department of the Interior, also plays an important part by increasing the value of the water powers of the province through its work in the construction and operation of storage reservoirs. The most important reservoir operated by the Commission is on the St. Maurice River, where the Gouin dam controls a storage capacity of 160 thousand million cubic feet of water, and more than doubles the power possibilities of the power sites on the river. It is the largest storage reservoir built for power purposes. The Allard dam on the St. Francis River stores 12 thousand million cubic feet, and the regulation of the river adds some 40,000 H.P. to its power possibilities. Two views of power developments on the St. Francis River are given in Figs. 2 and 3. The first shows the Drummondville station which has a capacity of 19,500 H.P., while the other shows the Hemmings Falls station which has a capacity of 37,300 H.P. Both stations belong to the Southern Canada Power Company, Ltd. Two reservoirs on the Ste. Anne de Beaupré River have been com-

THE C.P.R. GEARED-TURBINE PASSENGER STEAMER PRINCESS ELAINE

JOHN BROWN AND CO., LTD., CLYDEBANK, BUILDERS AND ENGINEERS



pleted, and considerably increase its dependable flow.

The St. Maurice River is the largest present source of power in the province, 557,000 H.P. being now installed at three sites. At Shawinigan Falls, the Shawinigan Water and Power Company has an installation of 191,500 H.P., while it also controls a 120,000 H.P. development at La Gabelle—see Fig. 4. In addition to these, the company secures power from a 176,000 H.P. development at Grand' Mere, owned by the Laurentide Power Company. Work was recently started by the company in connection with the installation of an additional 40,000 H.P. unit in its No. 2 plant at Shawinigan Falls.

The same company carried out a most notable achievement last year in the completion of a 165,000-volt transmission line, 135 miles in length, through an almost entirely uninhabited territory, to bring power from the Isle Maligne station of the Duke-Price Power Company on the Saguenay River to the city of Quebec. This line, which at present is the highest voltage line in operation in Canada, is designed to carry 100,000 horse-power for the supply of large pulp and paper mills recently erected in the vicinity of Quebec City. The transmission line is of double-circuit steel tower construction, with an average tower spacing of about 900ft. The line is destined for an operating pressure of 187,000 volts at the power-house, with a delivery pressure of 160,000 volts. Although from considerations of continuity of service and freedom from interruptions it was desirable to use two single-circuit lines on separate rights-of-way, the necessity of keeping down the capital cost of the line forced the decision to use a double-circuit tower line. The ultimate capacity of this double-circuit line when delivering power at Quebec at 160,000 volts is approximately 230,000 horse-power, but when the load to be transmitted to Quebec increases beyond 150,000 horse-power, a second double-circuit line will probably be constructed. Three types of towers are used on this line—light suspension, semi-anchor suspension and anchor strain towers—which weight 11,000 lb., 18,000 lb. and 21,560 lb. respectively. The vertical spacing of the conductors is 12ft., and the spacing between circuits is 24ft. on the upper and lower cross arms, and 34ft. on the middle cross arm. The centre conductor is offset 5ft. from the vertical plans of the upper and lower conductors, in order to reduce the danger of contact between conductors when sleet forms on the line. Two ground wires are carried on the top of the tower, 5ft. above the upper conductor support and 34ft. apart.

The standard light tower will be employed for angles in the line up to 4 deg. Its weight is about 11,000 lb., and the weight of the footing for each leg of the tower is 8100 lb. It consists of two cubic yards of concrete, with reinforcing bars. The overall height of the tower is 84ft. The semi-anchor tower is used at angles in the line between 4 deg. and 20 deg., and at some other points where, on account of special conditions, greater strength was required than that afforded by the light tower. The anchor tower is used at angles in the line greater than 20 deg., and also at points where long spans are economical, owing to the profile of the ground. The longest single span is 1755ft. Transportation towers are arranged at the third points of the line, and are similar to the anchor towers, except that the cross arms are modified to take the transportation jumpers. A sectionalising and paralleling switch structure is installed at the middle point of the line, and sectionalising switches are installed at points one-quarter of the length of the line from each end. Hand-operated horn-gap switches are used. The foundations of all the towers are of concrete with steel reinforcing.

The conductor used is aluminium cable, steel reinforced, with an outside diameter of ½in. It is made up of thirty strands of aluminium of 0·1151in. diameter over seven strands of steel of the same diameter. The elastic limit of the cable is 13,800 lb., and its ultimate strength is 19,170 lb. The calculated maximum operating stress is 10,000 lb. per conductor, when operating with ½in. of ice and a 10 lb. wind. The line can be operated up to 180,000 volts in fair weather, without any formation of corona about the conductors, and even in stormy weather the loss of power from this cause will, it is said, be very small.

The following figures give a general idea of the quantities of material involved in the construction of this line :—

Surveyed length of line	135·5 miles
Number of circuits	2
Total number of tower positions ..	797
Total weight of tower steel	5,000 tons
Size and type of conductor	397,500 cm. ACSR
Number of conductors per circuit ..	3
Total weight of conductors	1,335 tons
Size and type of ground wire	⅜in. dia. galv. crucible steel
Number of ground wires	2
Total weight of ground wire	300 tons
Approximate number of insulators	52,000 units
Approximate total weight of insulators and fittings	250 tons
Approximate total volume of concrete in tower footings	10,000 cubic yards
Approximate total weight of concrete materials	20,000 tons
Approximate average number of men employed	600

On the Saguenay River at Chute-à-Caron, the Alcoa Power Company is actively pressing the development of a plant which will have an ultimate capacity of 800,000 horse-power, while the Duke-Price Power Company has still two units to install in its Isle Maligne station to bring it to its ultimate designed capacity of 540,000 H.P. One of these units will be installed this year.

Other installations placed in operation during 1927 included the addition of a 2000 H.P. unit at the Pont Rouge plant of the Donnacona Paper Company on the Jacques Cartier River, and the completion of a 2000 H.P. hydro-electric plant by the town of Coaticook on the river of the same name, replacing smaller installations aggregating 570 H.P. Among projects or extensions under active construction may be mentioned a 65,000 H.P. development by the Montreal Island Power Company on Des Prairies River, near Montreal; the addition of two 10,000 H.P. units to the Canada Northern Power Company's plant on the Quinze River, to be ready about the beginning of July this year; and a 300 H.P. plant by the Cie d'Enterprises Publiques, near Rivière-à-Pierre, on the river of the same name.

The Canadian Pacific Passenger Steamer Princess Elaine.

IN the above engraving we illustrate the new 2000-ton Canadian Pacific Railway passenger steamer "Princess Elaine," which has been built by John Brown and Co., Ltd., at Clydebank, for the C.P.R. passenger and motor car ferry service between Vancouver mainland and Nanaimo, on the island of Vancouver. The distance is one of about 40 miles across the Strait of Georgia. The vessel has been designed and constructed to meet the requirements of Lloyd's A1 class and the Canadian steamship service regulations, and although she will mainly be used in the service above referred to, and in the Queen Charlotte Sound, she is also qualified to be used between Seattle, on the south, and Skagway on the north of her home port. The principal dimensions of the "Princess Elaine" are as follows :—Length between perpendiculars, 290ft. 9in.; breadth moulded at the main deck, 48ft.; breadth at the water line, 42ft. 6in.; and the depth moulded to the main deck, 16ft. The height between the main deck and the upper deck at the side is 11ft. 6in. With a gross tonnage of about 2000 the ship has a designed service speed of about 18 knots, and on her recent measured mile trials at Skelmorlie a speed of 19·8 knots was attained.

Three-screw single-reduction geared turbine machinery is installed, steam being raised in two water-tube boilers of the Yarrow type. They are fitted with large air heaters and are designed to burn oil fuel under forced draught conditions. The turbines are constructed to use saturated steam at a pressure of 200 lb. per square inch. On the centre screw there is placed the high-pressure turbine, with low-pressure turbines on the wing shafts. Astern turbines are also fitted on the wing turbines. The fuel oil capacity of the ship is such that she will be able to make the voyage from the Clyde to Victoria, Vancouver Island, *vid* the Panama Canal without having to refuel *en route*. The handsome appearance of the ship with her three funnels and two masts will be seen from our engraving. From the breadth dimensions we give it will be readily apparent that the hull design is such as to give a maximum deck area above the water line, while provision is made against too great a breadth at the water line itself. A special feature of the hull design is the lofty and pillar-free main deck. It has only a middle row of supporting pillars and is entirely reserved for the transport of motor vehicles. For this purpose large doors are provided in the sides of the ship, two forward and two aft, while at the after end of the deck there is arranged a flush turntable so that the direction of the cars can be reversed as required.

The upper deck is totally enclosed and an open saloon is arranged at the forward end. It may be used for dancing and social purposes. The seating is of the Pullman settee type, back to back, and is so designed that it can be converted into sleeping quarters with very little alteration. A dining saloon seating over a hundred persons is arranged forward on the orlop deck, and there are state rooms and other public rooms at the after end of the upper deck. Both the enclosed upper deck and the main deck are lighted by the large square windows which are seen in our illustration. A full complement of lifeboats is carried and the navigating equipment includes a searchlight forward, designed for use when entering port or when sailing in narrow waters. The "Princess Elaine" will have as a sister ship the "Princess Patricia," which was originally the "Queen Alexandra," one of the pioneer turbine-driven ships of the Clyde, and which still does excellent service in British Columbia.

The Reorganisation of Crewe Locomotive Works.*

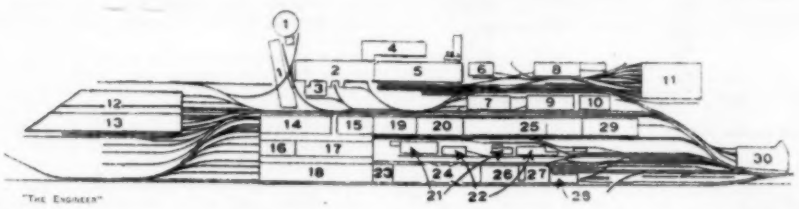
By CAPT. H. P. M. BEAMES.

CREWE Works were established in 1843 for the purpose of repairing the locomotive stock of the Grand Junction Railway. The works originally covered 2½ to 3 acres; the number of men employed was 161, and the stock of the company was 75 engines. As in the lay-out of many old works in this country, insufficient attention was paid to the possibilities of future expansion, housing accommodation for the staff being built in immediate proximity to the shops in which they worked. This, coupled with the fact that the site chosen was in a triangle bounded on the north side by the Liverpool line and on the south by the Crewe and Chester line, left only one direction in which the works could be extended. Fig. 1 shows the

* The Institution of Mechanical Engineers.

extent to which the works had grown at the termination of the war.

In early days the locomotive stock consisted mainly of six-wheeled engines. The introduction of eight-, ten-, and twelve-wheeled engines between 1900 and 1920, together with the increase of stock to upwards of 3400, increased the work of manufacture and repair to the following extent:—The tonnage (including engine and tender when empty) increased by 72,792 tons, whilst the length of the engine stock from buffer to footplate increased by almost 6 miles.



1. Brickmaking Mill.
2. Ironfoundry.
3. Chair Foundry.
4. Pattern Shop and Stores.
5. Tender Shop.
6. Brassfoundry.
7. Copper and Tube Shop.
8. Signal Shop.
9. Wheel Shop.
10. Nut and Bolt Shop.
11. Paint Shop.
12. Machine Shop.
13. No. 9 Erecting Shop.
14. No. 8 Erecting Shop.
15. Boiler Mounting Shop.
16. Plate Stores.
17. Flanging Shop and Smithy.
18. Boiler Shop.
19. No. 6 Erecting Shop.
20. No. 5 Erecting Shop.
21. Power and Boiler-houses.
22. Gas Producers.
23. Points and Crossing Shop.
24. Rail Mill.
25. Forge.
26. 20-ton Furnaces.
27. Spring Mill.
28. 30-ton Furnaces.
29. Steel Foundry.
30. Stoneyard.

FIG. 1

The increase is shown graphically and in detail in Fig. 2.

Owing to this growth and the fact that the old erecting shops were incapable of being altered to suit modern requirements in consequence of height, width, and other structural considerations, the want of suitable accommodation began to be acutely felt in 1913, and the extension of No. 9 erecting shop and the fitting shop was authorised. The war, however, interfered with the continuance of the programme, and it was not until 1919 that it was possible to continue the reorganisation of Crewe Works, the need being increased by the introduction of the 47-hour

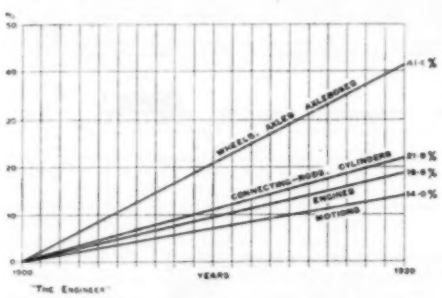
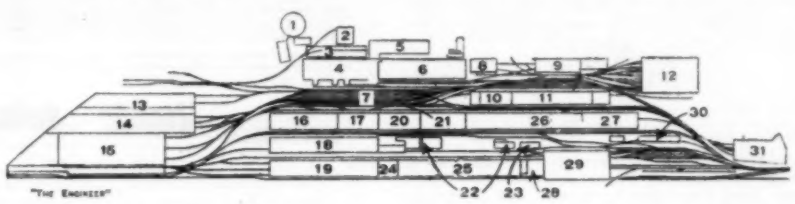


FIG. 2—INCREASE OF LOCOMOTIVE STOCK AND DETAILS, 1900-1920

week. In this year the construction of a complete new erecting shop was commenced alongside No. 9 erecting shop, but this was stopped at a later date. In 1921, the necessity of continuing the reorganisation became pressing, and a start was made on the re-equipment of the machine shop with modern machine tools, the extension of the wheel shop, and the removal of the smithy from the old works to the steel works, the old works being shut down and the work concentrated at the steel works end. At the same time it was decided to obtain what electrical power was required from the North Wales Power Supply Company; this enabled the three power stations within Crewe Works to be closed.

In 1922 the lay-out of the new Siemens-Martin steel furnaces was designed, and in 1924 it was decided to finish the reorganisation by the completion of the partially-built erecting shop and its extension so as to enable No. 9 shop and the new building to be formed eventually into one shop. The new shop would then accommodate the whole of the engines in the works for repairs. It was further decided to provide better siding facilities inside the works, to utilise the old erecting shops for the purposes for which they were most suitable, to cut down transport to a minimum, and to construct a new boiler-building establishment at the old works capable, if necessary, of manufacturing all the boilers required for the London, Midland and Scottish Railway. Reference to Fig. 3 will show that in this lay-out the old brick yard was demolished, the high ground on which it stood being removed so as to give the necessary siding accommodation shown in Fig. 4. This reorganisation affected the signal shop, tin shop, galvanising plant, joiners' shop, millwrights' shop, testing shop, wheel shop, tender shop, tube shop, smithy, iron foundry and machine shop, modern machines being installed where necessary.

In the lay-out of the reorganised works the use of the shops was rearranged so as to eliminate transport wherever possible, and the machines were installed so as to permit the manufacture and repair of component parts to progress process by process. For instance, the whole of the new boiler-building plant is now accommodated in the old works; each individual boiler-plate from the plate stores proceeds down the length of the shop as each successive



1. Brickmaking Mill.
2. Chair Foundry.
3. 6-ton Gantry.
4. Ironfoundry.
5. Pattern Shop and Stores.
6. Tender Shop.
7. Engine Storage Shed.
8. Brassfoundry.
9. Brassfinishing Shop.
10. Copper Shop.
11. Wheel Shop.
12. Paint Shop.
13. Machine Shop.
14. No. 9 Erecting Shop.
15. New Erecting Shop.
16. Finished Part Stores and Welders' Shop.
17. Mounting Shop.
18. Smithy.
19. Boiler Repair Shop.
20. Tube Shop.
21. Heavy Machine Shop.
22. Power and Boiler-houses.
23. Gas Producers.
24. Points and Crossings Shop.
25. Rail Mill.
26. Forge.
27. Steel Foundry.
28. Spring Mill.
29. New Melting Furnaces.
30. Ingot Stacking Gantry.
31. Stoneyard.

FIG. 3

operation is performed, and it is eventually delivered to the riveting machines at the west end of the building flanged and machined ready for assembling. The whole of the work is performed by modern high-power machines. The actual building of the boiler also progresses in the same way, the men being kept in one position and the boiler moving from stage to stage.

Heavy Machine Shop.—No. 5 erecting shop, which adjoins the forge at its western end, has been converted into a heavy machine shop, in which frames, hornblocks, cylinders, footplates, &c., are machined and assembled complete. The rolled frame plates now pass immediately from the rolls at the west end of the forge to the slotting machines at the east end of the heavy machine shop, the latter being laid out so that work progresses in a westerly direction, eventually leaving as a completely assembled frame *en route* to the erecting shop by road on the south or north side of the shop as may be found most convenient. The most notable machines in the heavy machine shop are a plano-cylinder milling machine and a horizontal cylinder drilling, boring, tapping, and milling machine.

Engine Erecting Frames.—These consist of three machines, each capable of taking the longest locomotive. Sunk in the floor of the shop are long, accurately machined, cast iron girders—Fig. 5—on which sliding supports for the frames can be fixed at the exact centres corresponding to the type of engine being built. The frames, with horns complete, are dropped on to these supports. The supports centralise the horns, thus ensuring that the frames are square and at the correct height one from another. They also give the exact position for fixing cylinders, motion plate, footplates, &c. These have only to be dropped in place between the frames and bolted up, and once the machine is set up locomotives exactly similar, so far as centres are concerned, can be erected without the aid of wires, trammels, &c. As most of the machine tools in the shops are independently motor driven, little shafting exists, but where shafting has been installed it is fitted throughout with ball bearings.

Machine Shop.—The work of the machine shop, which previously included both production and repairs of all components, was divided up. Brass work was removed to the old signal shop close to the brassfoundry, and heavy machine work, such as that in connection with frames, hornblocks, cylinders and footplates was concentrated, as, has been stated, in what was previously No. 5 erecting shop. The machine shop itself now consists of two bays, each 42ft. by 660ft. long, and an arcade 40ft. by 740ft. long, equal to an area of 85,000 square feet, and contains the combined plant from the old works and the steel works comprising 422 machines. Shaping and planing operations have been superseded by milling, and pins, shafts, and various bearings, which were previously finished by turning, are now ground to fine limits on modern machines. The limit system is on the "unilateral" principle with the hole as a base, a plus allowance on the standard, and a minus allowance on the shaft. A standardised supply of limit gauges is available.

Before the present reorganisation each section was arranged so that the machinery dealing with the various sectional parts was grouped close to the benches where they were stripped and assembled. Congestion was, however, so great as to interfere with the transport and progress of the work.

New and complete plant for the manufacture of pistons and all bar work has been installed, and in this department is also situated the tool-room in which the tools are not only repaired and ground, but all the large twist drills, taps, cutters, reamers, gauges, &c., used in the works are manufactured. A total of 121 new machines has been installed in this shop, consisting of turret and capstan lathes, shaping and slotting machines, drills, and milling and grinding machines, by all the best-known machine tool makers. Economical use of high-speed steels is made by providing carbon steel tools with tips of high-speed steel of minimum size. A further aid to output is the adoption of a standard tool shape, ground from the solid on oscillating tool grinders; this eliminates the forging of tool shapes. Group driving is arranged where it is economical, having always in view the desirability of standardising motors.

FIG. 4—YARD FOR STABLING ENGINES

FIG. 5—FRAME JIG WITH FRAME PLATES

No. 9 Erecting Shop.—Adjoining the machine shop is No. 9 erecting shop, which consists of two bays—north and south—803ft. and 882ft. long respectively and each 45ft. wide, with a machine bay between them. Six 40-ton, one 6-ton, and one 4-ton electric overhead cranes serve this shop.

Prior to the reorganisation all the heaviest locomotives coming into Crewe Works had to be repaired in this shop. The method of approach was by lines from the east end and a traverser about two-thirds of the way down the shop. It is now possible to utilise the south bay of this shop for light boiler repairs, and thus avoid transferring boilers from the erecting shop to the boiler repair shop.

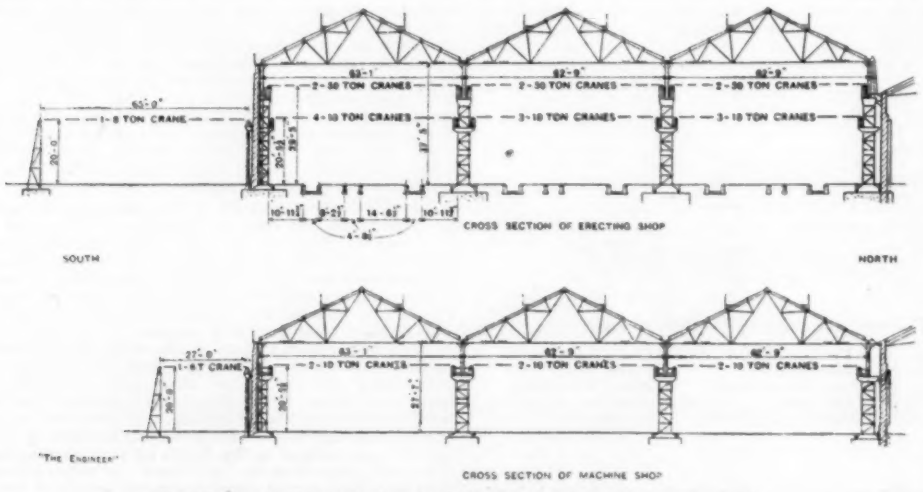


FIG. 6—CROSS SECTIONS OF NEW ERECTING, AND MACHINE SHOPS

New Erecting Shop.—A new erecting shop has been constructed immediately adjoining No. 9 shop, as shown in Fig. 3; a cross section of this shop and the new machine shop is shown in Fig. 6, and a photograph in Fig. 7. It will be observed that it consists of three erecting bays each 642ft. long and 63ft. wide. Each bay is provided with two pits and a central road. Spanning these pits are two 50-ton four-motor overhead cranes, particulars of which are as follows:—

	Speed, ft. per min.	Motor, horse-power.
Hoist	6	30
Auxiliary hoist	20	12
Cross travel	80	12
Longitudinal travel	200	30

There are also three 10-ton three-motor overhead cranes, with an additional crane in the south bay to deal with wheels, which have the following speeds and power:—

	Speed, ft. per min.	Motor, horse-power.
Hoist	20	20
Cross travel	100	3
Longitudinal travel	350	16

The motors are of the alternating-current slip-ring type, 416 volts, three-phase, 50 cycles frequency. It will be noticed that the high-speed light cranes are run at a lower level than the heavy overhead cranes, for as a result of the increase in size of engines many parts that were previously lifted by hand are now of such weight as to necessitate mechanical assistance. The whole of the pits have been constructed of ferro-concrete.

The framework of the shop is a steel structure forming a complete unit and is designed to withstand the loads and wind pressure on the building. The south, east, and west gable walls are of brick and take no portion of the working loads of the shop. The floor is constructed of wood blocks on edge, and concrete paths for electric trucks are provided where necessary. The roof is of glass, and all astragals, &c., are lead covered. Some criticism was raised to the effect that the shop would be unduly hot during the summer. Records taken in 1926 show that there were only nine occasions during the year when the temperature reached 80 deg. Fah. The heating of the shop is by means of steam and is of the overhead type. The system is split up into twelve sets of pipes, each set consisting of one steam flow pipe and two return pipes. Two sets are located on either side of each erecting shop and machine shop bay, and are placed above the bottom tie of the roof principal. The condensate is returned to the boiler as feed water. The whole of the system is divided into four main portions for the purpose of providing efficient circulation, main steam supplies being taken at three points. With this system it has been found possible to maintain an inside temperature of 55 deg. Fah. when the temperature outside is at freezing point. Four water-tube boilers are installed, three working and one standby. These, in addition to supplying steam for heating the new erecting shop, also provide for the heating of No. 9 erecting shop, the machine shop and all boshes.

The shop is electrically lighted by alternating current at 416 volts. Main lights are placed overhead at both sides of each bay, and under the 10-ton crane-way. Plugs are provided immediately above the fitters' benches for driving portable machine tools and for providing auxiliary lighting.

At the west end the traverser table working into No. 9 shop is able to traverse the whole of the new erecting shop on the southern side. On either side of this traverser eighteen pits allocated solely to the stripping of engines have been constructed, whilst immediately adjoining are installed mechanically operated boshes for cleaning the stripped parts. Reference to Fig. 3 will show a triangular portion at the west end of the shop which is devoted to reconditioning those portions of the locomotive not requiring transport to the machine or wheel shop. A cross section is shown in the lower half of Fig. 6. The capacity of the shop is sixty-six engines, taking the engine length plus an allowance for a gap between each engine at 42½ft., and the output from the shop is equal to thirty to thirty-five heavy repairs per week and a hundred new locomotives per annum.

Before coming to a decision as to the design of this shop very careful consideration was given to the claims in support of longitudinal as against cross pits, and the probability of the future reconstruction of No. 9 shop was also taken into account. As will be seen from Fig. 3, it will be possible at a future date to reconstruct it so as to form a portion of the large shop.

Processing Repairs of Locomotives.—The method of processing the repair of locomotives is representative of the principle, now employed throughout the works, of moving the work to the man rather than the man to the work. The locomotive is moved down the shop in eight successive stages. At each stage the appropriate components are added by men expert in their particular work, and the duration of the working time in each stage is regulated to 7 hours 50 minutes. By this means an engine is stripped and given a heavy repair in twelve days, as compared with thirty to forty days generally occupied on such work. The complete progress of the work is illustrated in Fig. 8. An engine requiring a heavy repair is brought into the erecting shop over the traverser at the west end of the shop and is placed on one of two positions immediately adjoining the traverser. It is here stripped of its wheels, motion, boiler, and all other parts requiring repairs, this occupying two working days, during which the parts for repair are distributed to the appropriate shops. The staff engaged on stripping the engines are confined to this work, and as two engines are stripped simultaneously there is an output of one stripped engine per day.

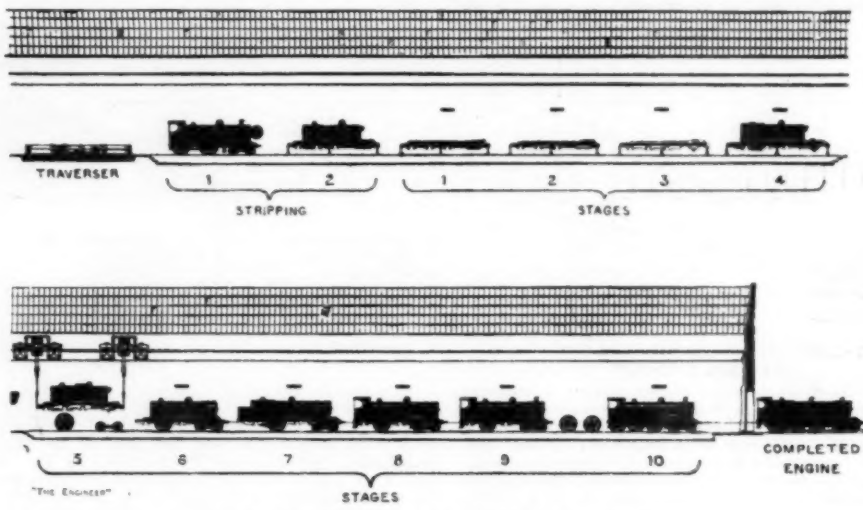


FIG. 8—PROCESSING OF REPAIRS TO LOCOMOTIVES

On completion of stripping, one engine frame daily is placed on its stand on one of the four adjoining positions in the pit, these positions being numbered stages 1, 2, 3, and 4. The gangs, of which there are four, move between stages 1, 2, 3, and 4 as they finish their own particular work at a stage. Four working days are allowed for an engine frame to remain on its stand. On the fifth day, the intermediate and truck wheels have been returned repaired,

FIG. 7—NEW ERECTING SHOP

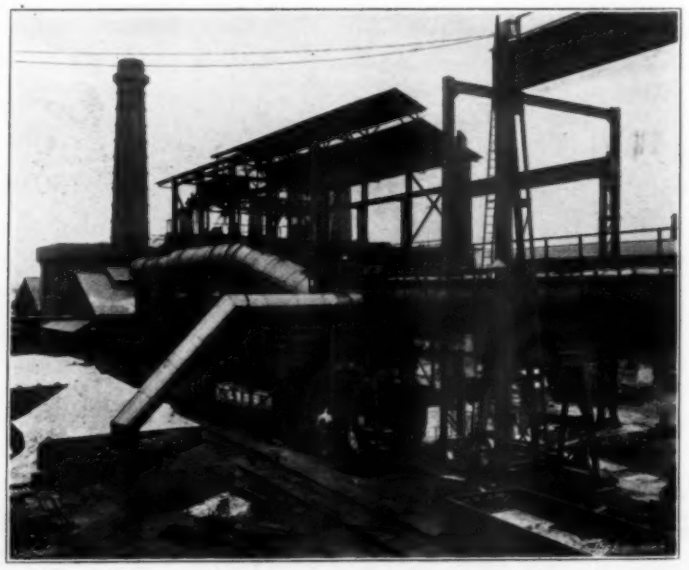


FIG. 9—GAS MACHINES

ready for the frame and boiler from one of the first four stages, to be lifted on to the wheels. In stages 1, 2, 3, 4, and 5 the following work is carried out :—

Stage 1.—Cleaning tops of cylinders, ends and covers ; examination of frames and cylinders. Removing steam chest liners ; drilling studs, set-screws, &c., on cylinders and frames, and welding any cracks. Welding frames ; replacing dragbox ; (boring cylinder) ; fitting studs.

Stage 2.—(Fitting steam chest liners) ; refitting pivot casting ; (chipping and grinding frames after welding). Boring steam chest liners ; replacing hornblock patches. Remaking back cylinder cover joints.

Stage 3.—Setting slide bars ; fitting hornblock keeps ; straightening front end. Setting radius rod brackets ; fitting studs for guide brackets ; filing hornblocks. Mounting boiler in frame and bolting up.

Stage 4.—Fitting 3½in. exhaust pipe brackets, wash-out plugs, and blow-off cock ; mounting whistle stand. Mounting cylinder cocks and gear, intermediate oil pipes, safety valve and fitting crossheads. Fitting pistons and rings, cylinder covers and packing. Lagging ashpan and fitting damper doors.

Stage 5.—Adding radial truck and intermediate wheels under engine. Mounting vacuum sack and brackets, buffer plank, draw-bar hook, increased brake guide or rocking shaft brackets, piston valves, damper gear and part of lubricator gear.

Thereafter the locomotive is hauled down the shop to stages 6, 7, 8, 9, and 10, moving one stage per day. Each day the following work is carried out :—

Stage 6.—Mounting buffers, stiffening plates, lamp brackets, snifting valves, and air pump. Fitting panels, expansion brackets, dirt plates, reversing screw and rods, reversing shaft quadrants, &c., and rocking gear.

Stage 7.—Carrying out part of smoke-box work, mounting steam pipes and bolting up smoke-box. Mounting injector and cab, locking gear, sand gear and lubrication to axle-boxes. Refitting splashers, sand boxes and footsteps.

Stage 8.—Completing smoke-box work ; finishing cab and footplate ; fitting 3½in. exhaust pipe. Mounting mechanical or Detroit lubricator and pumping oil through.

Stage 9.—Mounting wheels and setting in position. Fitting up motion and connecting-rods. Wheeling engines, bolting up hornblock keeps, stays, centre bearing wedges and cap. Fitting radial truck pivot studs and nuts, cylinder cock pipes and brackets, oil pipes and brackets.

Stage 10.—Fitting up brake work, coupling rods, crank pin washers, sand pipes and stays. Assisting valve setters. Fitting steam chest covers, covering plates and door. Adjusting weight and lifting engine off pit.

On the twelfth day—allowing two days for stripping—the engine is hauled out of the shop completely repaired. Such a method of repairing engines enables various appliances to be used for facilitating the erection of components, which are always kept in the same place, instead of having to be carried about the shop, such as a screw jack for the erection of the vacuum sack and bogie pivot casting, staging for riveters working on the smoke-box, and appliances for lifting connecting and coupling rods.

When this system was first brought into operation the engines were hauled down the shop by means of an overhead crane working round a snatch block sunk into the floor of the pit, each engine being attached to the next by a wire cable. Two electric winches placed outside the erecting shop have now superseded the overhead cranes, and in consequence the loss of time for lifting has been reduced. In the first instance this system of repair was concentrated on one type of six-coupled express passenger engine. Development of the system, however, has made it possible to have as many as five different classes of engines on what is locally known as "The Belt" at one time, this alone being made possible by the fact that the repairs to boilers, tanks, panels, splashers, cabs, injectors, ejectors, drivers' valves, vacuum sacks, axle-boxes, tubes, bogies and superheater elements are all processed in this way, the processing of the locomotive itself being the final and spectacular result of the system generally. Obviously it is necessary to have certain spare parts available before such a system can operate. Experience shows that at least two sets of spare wheels, two pairs of cylinders, four sets of axles, and ten crank pins per class of engine repaired, and 6 per cent. of spare boilers, together with the various nuts and bolts, should be accumulated before attempting to work to this system.

There are now in operation four belts, dealing with seventeen different classes of engines, each belt of twelve engines giving an output of one engine per day throughout the working week. Since the first engine was turned out by this system on May 5th, 1927, over 700 engines have been repaired without any delay whatever. It should be mentioned that the pre-arranged times of movement are most strictly worked to, a clock which is altered daily showing the time for the move the next day. A move is made on the blowing of a buzzer in the shop. This time limit is one of the most important features of such a scheme. The knowledge that component parts must be delivered in time to be put in before the next move proves a powerful incentive to every shop in the works.

Tenders are now being repaired in the tender shop on much the same principle, the time taken for a heavy repair being four days, as against eight to nine days under the old method. The wheel stacking ground on the south side of the shop is equipped with a 6-ton three-motor overhead crane with gantry 364ft. long and 27ft. span. The following are the particulars :—

	Speed, ft. per min.	Motor, horse-power.
Hoist	20	12
Cross travel	80	3
Longitudinal travel	350	12

Adjoining this is the stacking ground where all cabs, panels, splashers and other material not immediately requiring repairs are stored. Spanning this ground are two 8-ton three-motor overhead cranes with gantry 588ft. long and 65ft. span, of which the following are the particulars :—

	Speed, ft. per min.	Motor, horse-power.
Hoist	20	16
Cross travel	100	3
Longitudinal travel	350	16

Motors are of the slip-ring alternating-current type, 416 volts, three-phase, 50 cycles.

Boiler Repair Shop.—This has now been converted into purely a repair shop for boilers coming from the erecting shop. Access to any bay of this shop can be obtained from any bay of the erecting shop *viâ* the traverser, without crossing other roads as was formerly the case. Such repairs as the provision of new fire-boxes and new wrapper plates can be carried out here with materials supplied from the new boiler building establishment. On completion of the repairs boilers pass to the boiler mounting and testing shop and then back to the erecting shop. In rearranging this shop the opportunity has been taken of processing the work.

Steel Works.—Since 1864 steel has been manufactured at Crewe. In 1923 the plant consisted of seven 20-ton and three 30-ton hand-charged furnaces heated by sixty-four small hand-fired water-bottom steam-blown "Wilson" type producers. In November, 1923, it was decided to modernise the whole plant. The new lay-out consists of two 40 to 45-ton acid open-hearth furnaces and two 60 to 70-ton basic open-hearth furnaces with an estimated yearly output of 84,840 tons of ingots. A cross section of the new steel making plant is shown in Fig. 10.

An open stockyard 400ft. by 63ft. 9in. is served by two 10-ton overhead electrically operated cranes, each fitted with a 5-ton lifting magnet. Three wagon roads pass through and accommodate all the wagons containing the raw material required.

The furnace bay is 400ft. by 59ft. 6in., giving a working space in front of the furnaces varying from 34ft. to 37ft. 6in. The furnaces are of the most modern type. The gas and air out-takes from the slag chambers are built up separately with air circulation all round, thus preventing the possibility of mixing and consequent destruction of the brickwork. The regenerators are placed well away from the furnaces. The furnace hearth is carried quite clear and independently of the slag pocket area, and the entire hearth and port ends are joined up in a strong independent framework carried on the furnace bottom joists.

The hearth of the acid furnace at fore-plate level is 11ft. wide by 28ft. long, giving an area of 308 square feet, or 7·7 square feet per ton of furnace capacity. The hearth of the basic furnace at fore-plate level is 14ft. wide by 36ft. long, giving an area of 504 square feet, or 8·4 square feet per ton of furnace capacity. The regenerators are capacious. In the acid furnace they contain 10·1 cubic feet per square foot of hearth area, and in the basic furnace 10·7 cubic feet per square foot of hearth area.

Gas Machines.—The sixty-four old hand-fired gas pro-

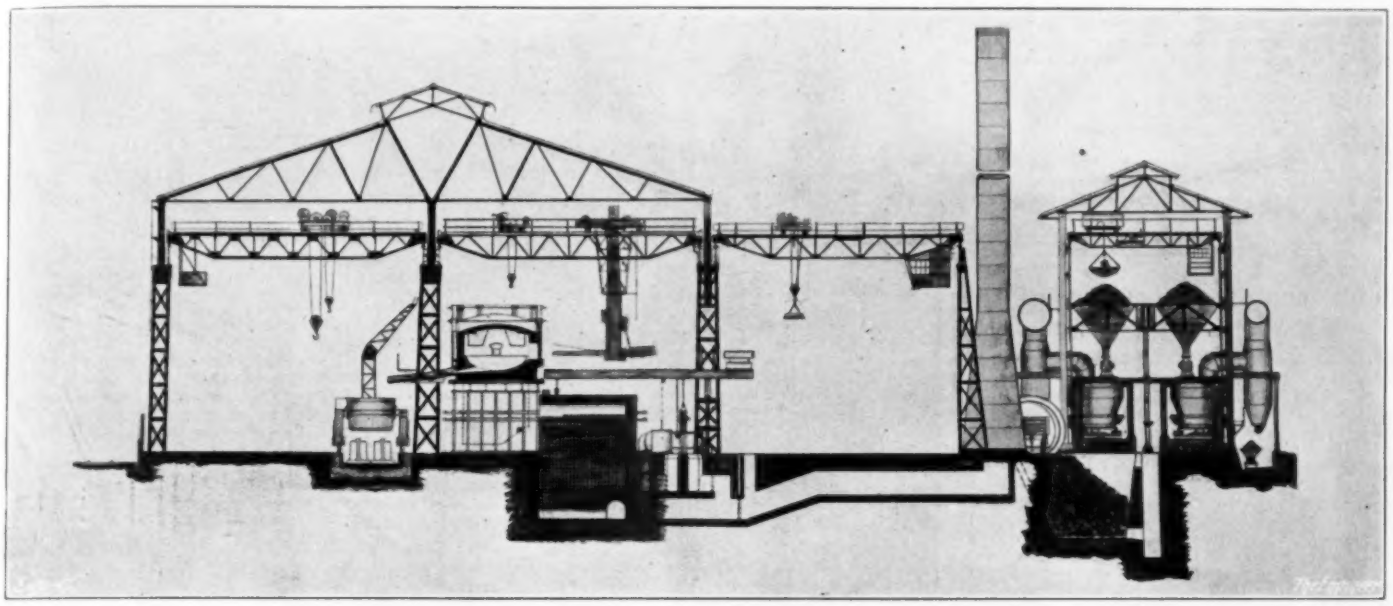


FIG. 10—CROSS SECTION OF STEEL MAKING PLANT

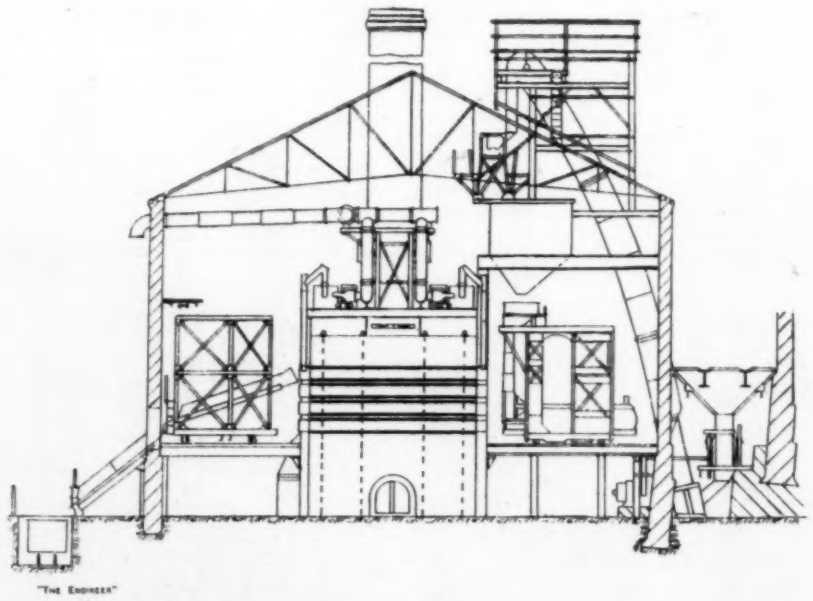


FIG. 11—CREWE GAS WORKS—CROSS SECTION THROUGH RETORT HOUSE AND BENCH

ducers have been replaced by six mechanical gas machines, Fig. 9. They are designed to gasify all the coal required to operate the new melting furnaces and in addition supply the forge and rolling mills and the reheating furnaces with the necessary gas.

Gasworks.—Gas for the illumination of town and company's property has been manufactured on the present site since 1884. The capacity of the plant—1,239,000 cubic feet per day—being taxed to its utmost, it became necessary to rebuild and enlarge the station. This has now been carried out by the erection of a new mechanically operated installation of horizontal retorts, with water gas plant, waste heat boiler, condensing towers, wet purification and dry purification plants and the provision of a 1,000,000 cubic feet holder—Fig. 11.

The results obtained from the reorganisation may be summarised thus: reduction of transport costs; decreased manufacturing costs of steel, locomotive boiler and all components; increased output of repairs and renewals with decrease in overtime and night-shift working; decreased time of locomotives out of traffic; and consequently less stock of locomotives required; reduction in quantity of portable tools and in labour costs; lower supervision costs in erecting shop; decreased cost of electric current and of gas; and finally, the reorganisation enables Crewe to cope with the increased size of locomotives and the additional requirements due to the grouping of the railways.

The Recent Development of the Marine Steam Engine.

In a paper on "Recent Developments in Propelling Equipment Practice of Reciprocating-engined Steamers," which was read on Tuesday last, March 13th, before the Institute of Marine Engineers, Mr. G. R. Hutchinson reviews some of the more important changes which have recently taken place in marine steam reciprocating engine practice. In introducing his subject, the author remarks that the steam engine is still the most widely used form of prime mover for mercantile vessels, despite the advance made by the heavy-oil engine for ship propulsion. The reasons for this sustained popularity, Mr. Hutchinson tersely expresses as follows:—It is the cheapest form of marine engine; it is probably the most reliable; it is universally understood, and will continue to work as no other marine engine will, complainingly perhaps, but dependably, when in a condition of neglect and lost efficiency, which is at once the admiration of its operators and the despair of its builders. It is somewhat remarkable, he goes on to say, that since Dr. A. C. Kirk introduced the triple-expansion engine in 1884, apart from attempts to introduce patented forms of valves and valve gears, there has been no serious departure from the basic principles of design, and this statement also applies to the more recently introduced quadruple-expansion engine. After showing the nature of the losses in the marine steam engine by comparing actual and ideal diagrams, these losses are grouped by the author under three following heads:—(1) Losses due to initial condensation and wire-drawing; (2) clearance losses; and (3) losses due to the expansion of the steam not being fully utilised in the low-pressure cylinder of the engine. The effects of different valve gears and the use of superheat in minimising these losses are then considered at some length, and the probable future development of the poppet valve type of marine engine is discussed, along with the advantages which would seem to be offered by the uniflow type of marine steam engine, both for main propelling and auxiliary machinery.

Mr. Hutchinson considers that the Bauer-Wach system of combining an exhaust turbine with a steam reciprocating engine offers a good remedy for those losses, which may be attributed to the dimensional limitations of low-pressure cylinders.

The second part of the paper is essentially descriptive in character, and in it examples of recent practice are given to illustrate the points which are brought out in the first part of the paper. Reference is made to the Arnhem quadruple expansion engine, in which a neat arrangement of valves and valve chests is employed, after which a description is given of the Sulzer uniflow engine, with oil-operated valve gear, which was built for the Geneva Lake steamer "Helvétie," and of which a fully illustrated description will be found in THE ENGINEER of June 24th, 1927. The Bauer-Wach exhaust turbine system recently dealt with by Dr. Gustav Bauer, in a paper given before the Institution of Engineers and Shipbuilders in Scotland, is described and illustrated, after which descriptions are given of a small vertical uniflow steam engine built by Henry Watson and Co., Ltd., of Newcastle, for auxiliary purposes, and the recent developments of the Lentz and Beardmore-Caprotti gears and the Meier-Mattern valve gear, which was described in THE ENGINEER for February 3rd last.

In concluding his paper the author remarks that with the data available at present it is not possible for one individual to give a considered scientific opinion of the economic value of the developments he describes, but he expresses the hope that at some future date a representative committee, somewhat on the lines of the Marine Oil Engine Trials Committee, might be jointly formed by the technical institutions to collect trial data and service performance from vessels fitted with different types of improved steam reciprocating machinery, and present them in the form of reports from which the economic value of the different designs might be appraised.

INDEX TO BRITISH STANDARD SPECIFICATIONS.—The 1928 edition of the "Index to British Standard Specifications and Reports" has just been issued. It is a complete subject index, which, in view of the large number—over 300—of British Standard Specifications now available, some of which include provisions for several articles or materials, will be of much assistance to those purchasing engineering and allied material, apparatus and machinery. A numerical list of the specifications is also included. The list, which covers thirty pages, shows the wide range of subjects covered by the British Standard Specifications. Copies are available from the Publications Department, British Engineering Standards Association, 28, Victoria-street, London, S.W. 1, price 1s. 2d. post free.

The Shannon Power Plant.

No. I.

In a short series of articles appearing in our columns during the latter part of last year we dealt with the civil engineering work associated with the Shannon power scheme, and we now propose to describe the plant that is to be erected in the generating station at Ardnacrusha. At the outset there are to be three turbines, each capable of giving a maximum output of 38,600 H.P., two of which are being supplied by J. M. Voith and Co.,, of Heidenheim, and the third by Escher, Wyss and Co., of Zurich. All these turbines will develop this output with a maximum head of 33·7 m., or 110·6ft., with a water consumption of 102 cubic metres per second. The useful head of water at the power station will depend on the ebb and flow of the tide in the lower part of the Shannon, and the head will vary from 26·43 m. to 33·73 m., or from 86·7ft. to 110·6ft. The table in the next column gives the outputs and efficiencies of the Voith turbines, with the different heads and the volume of water used.

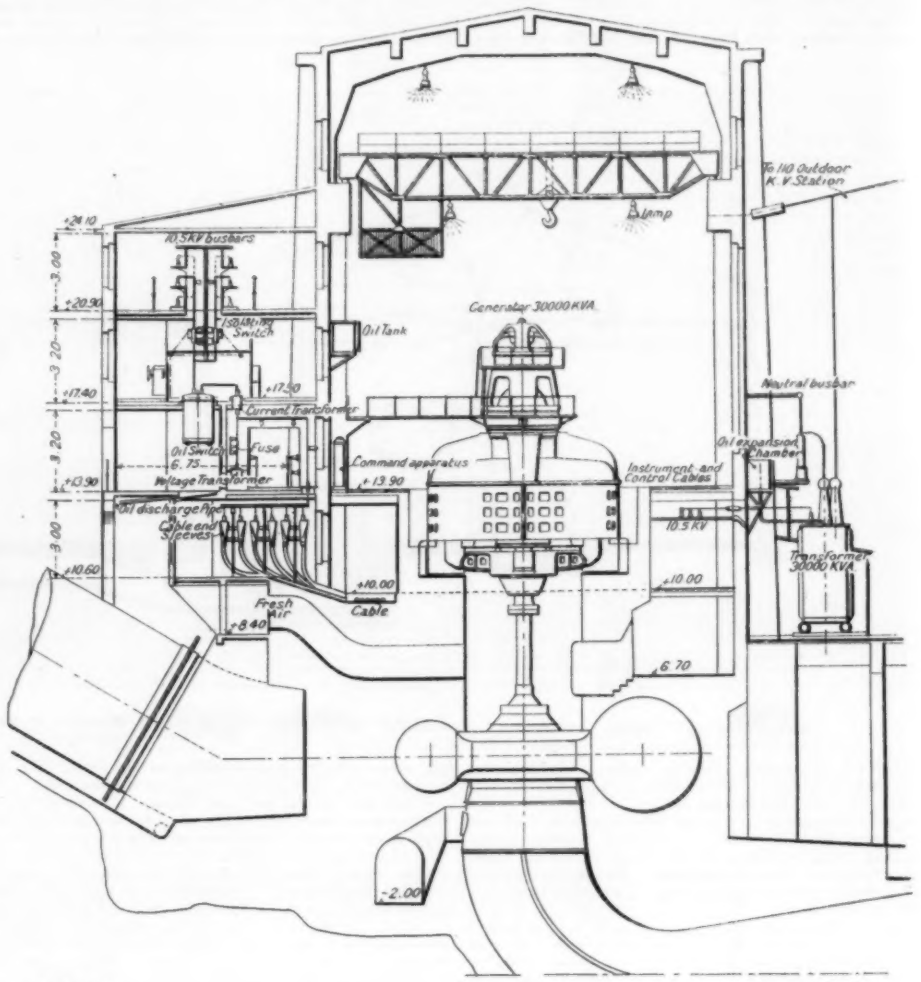


FIG. 1—ARRANGEMENT OF TURBINE AND GENERATOR

The drawings, Fig. 1, give some idea of the arrangement of the power plant and switchgear. From the sluice house shown in the cross section, Fig. 2, the water will be conveyed to each turbine by a pipe line, or 15·7ft., and the maximum overall diamension is about 19 m., or 46ft. These spiral casings are among the largest that have been built. As will be seen from Figs. 3, 4 and 6 the steel plates of the casings sections are riveted together, but owing to their size it was impossible to dispatch the casings complete. The whole of the casings of the Voith machines were assembled by means of bolts and nuts in the workshops at Heidenheim, whilst Escher, Wyss assembled

Head. m.	Volume of water per second. m³.	Horse-power.	Efficiency. per cent.
33·73	102·0	38,600	84
28·50	96·2	31,000	85
28·50	80·9	27,150	88
28·50	71·1	23,258	86
28·50	62·1	19,400	82
28·50	53·9	15,500	75·5
Constructed for—			
28·50	93·1	30,000	85

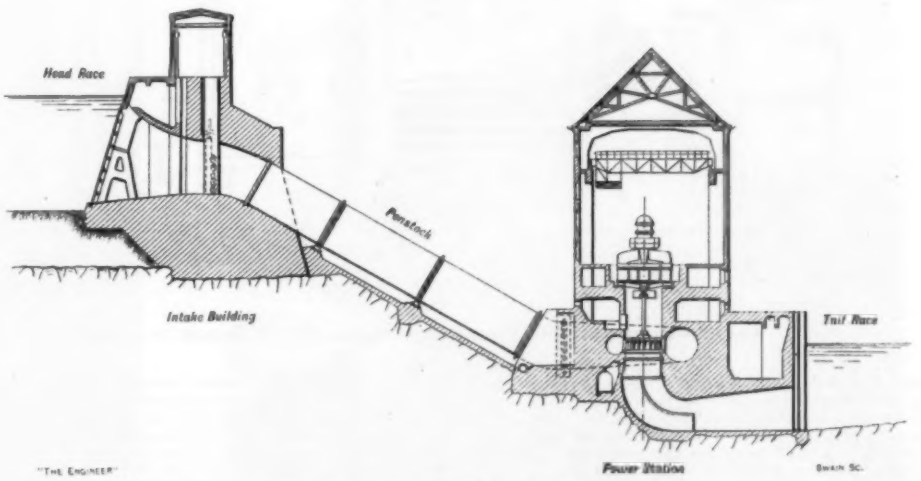


FIG. 2—PENSTOCK AND POWER STATION

TURBINES FOR THE SHANNON HYDRO-ELECTRIC POWER STATION

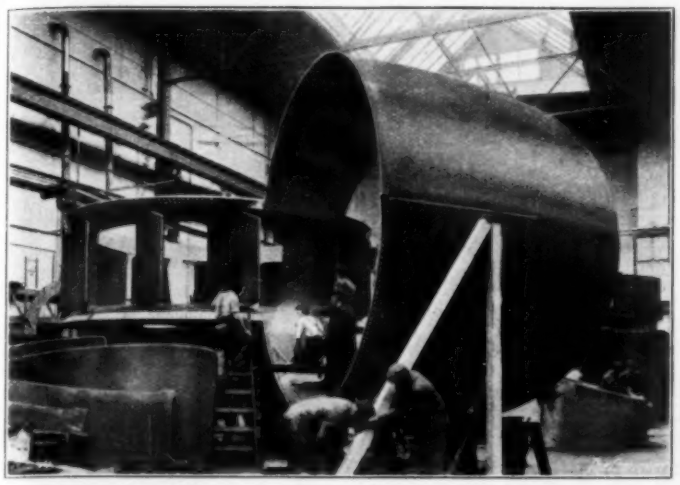


FIG. 3—BOLTING PART OF SPIRAL CASING TO SPEED RING—VOITH

FIG. 4—COMPLETE SPIRAL CASING IN SHOPS—VOITH

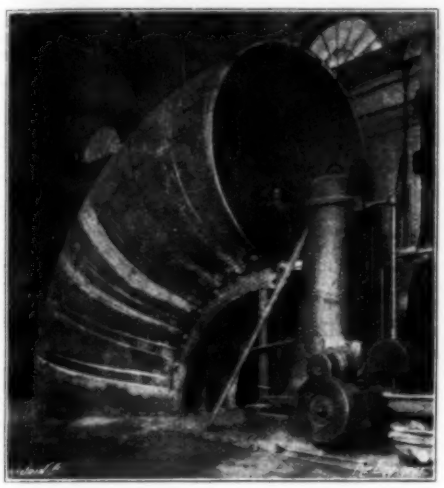


FIG. 5—PART OF SPIRAL CASING—ESCHER WYSS

FIG. 6—RIVETING SPIRAL CASING

FIG. 7—SPEED RING—VOITH

the four parts of the casings separately, and a template was made having the exact shape of a quarter of the inner ring to ensure that the four parts would accurately fit together. All the parts of the casings and the complete speed rings have been delivered to the power-house site, and when the building has been erected, the casings will be riveted together in position and surrounded by concrete in the ordinary way. In order to ensure that the stresses produced by the water pressure shall be completely taken by the casing and that the concrete will not be exposed to additional stresses, the plates of the casing have been given adequate thickness, the greatest thickness being 18 mm. The joints of the Escher, Wyss spiral casings have been covered with butt straps, whereas those of the Voith casings are lap riveted. Part of one of the spiral casings for the Escher, Wyss machine is shown in Fig. 5. The illustration, Fig. 3, shows a a portion of one of the Voith spiral casings being temporarily bolted to the speed ring in the Voith works. The speed rings—see Fig. 7—are 5·8 m., or 19·0ft., in diameter, the weight being 21,000 kilos., or 20·7 tons. Each speed ring is placed on a supporting ring set in concrete. From the vanes cast in the speed ring the water passes through the guide apparatus into the runner. The guide vanes which regulate the passage of water are supported with their spindles in the turbine cover, and are connected by means of cranks and links with the governor ring. The cranks, which operate this ring, are provided with safety bolts, so that in the event of a hard body lodging between two guide vanes, that are in the act of closing, a bolt breaks and only one of the guide vanes will be put out of action, the remaining vanes still being controlled by the governor ring, which is operated by two oil servo-motors, directly connected to the ring, which is submerged in oil. Special precautions are taken to ensure that the guide vane journals are well lubricated. The servo-motors are controlled by a governor on each turbine at the level of the turbine-room floor, where there will be a tachometer, an indicator for showing the position of the guide vanes, and various other operating instruments. The oil for the servo-motors will be supplied by motor-driven gear pumps arranged together with the air chambers in a passage at the same level as the servo-motors. The pumps will be interconnected and two pumps are capable of supplying three units, so that in the event of a pump failing the supply of oil will still be maintained. An auxiliary turbine with an output of 236 horse-power will drive a spare pump connected with these oil pipe lines, and also a generator on the same shaft. This auxiliary set, which is shown in the left-hand corner of the drawing, Fig. 8, is being supplied by Escher, Wyss and Co. The pump will run simultaneously with the main generating sets, and will serve as an additional standby, whilst the

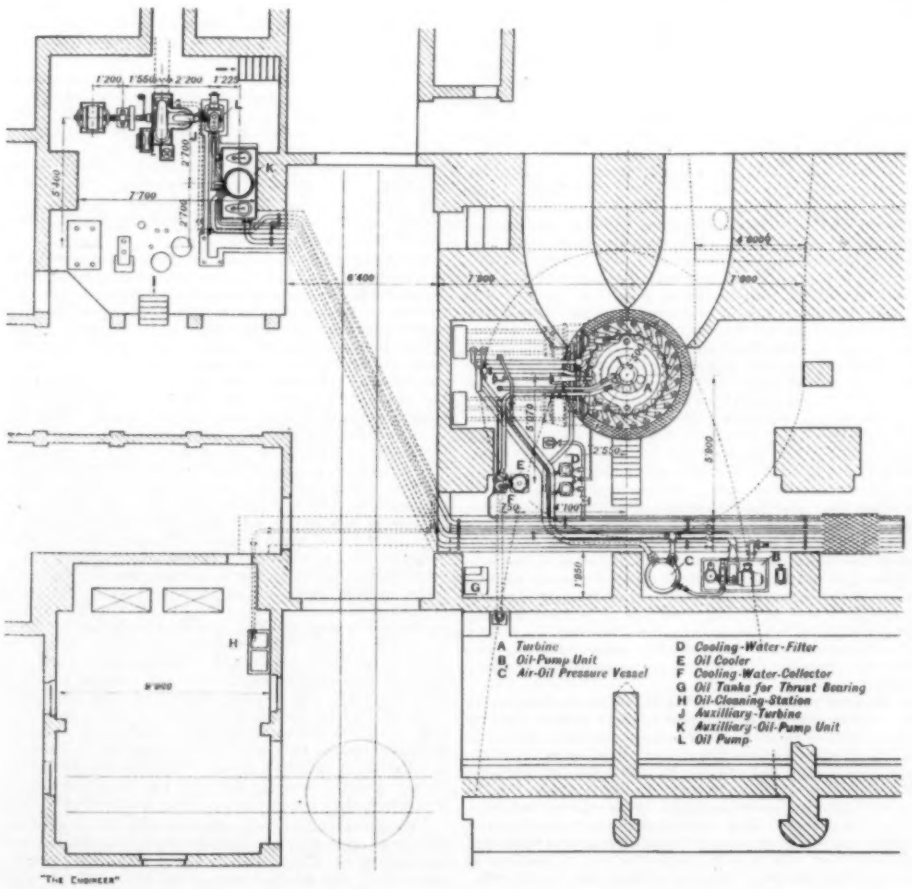


FIG. 8—PLAN VIEW OF ESCHER, WYSS MAIN TURBINE AND AUXILIARY HOUSE SET

generator will provide current for auxiliary purposes, such as the operation of the turbine sluices, in the event of the main generators being put out of action. The pressure of the oil used for the servo-motors is 25 atmospheres. The operating thrust of the servo-motors is 100 tons.

The cast steel runner of each of the Voith turbines —see Fig. 9—is 4·2 m., or 13·8ft., in diameter, and weighs 20 tons. The turbines are of the high-speed type with a specific metric speed of 400, which enables a speed of 150 revolutions per minute to be reached, thus permitting the employment of vertical generators of relatively small dimensions. The total load of the

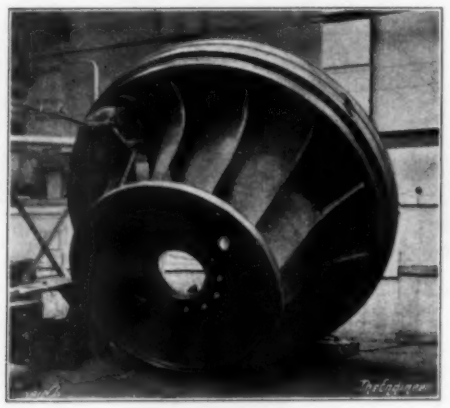


FIG. 9—TURBINE RUNNER—VOITH

revolving parts, together with the water pressure of the turbine runner, is carried by means of a Voith segment thrust bearing, capable of carrying a maximum load of 500 tons, the diameter of the cast iron bearing rings being about 1·9 m. A view of one of the Voith thrust bearings is given in Fig. 10. Heat due to friction is dealt with by an oil cooler, through which water passes, and also by a cooling coil in the thrust bearing housing. In both cases the cooling water is taken from the spiral casing, the oil being circulated through the cooler by a gear pump, driven by the turbine by spur wheels. For lubricating the white metal lined guide bearings another gear pump is

FIG. 10—THRUST BEARING—VOITH

driven from the turbine shaft. The runner shaft is supported at three places in the turbine cover, and also above and below the rotor of the generator. For checking the temperatures of the bearings and of the oil and water cooling circuits, suitable apparatus will be provided with auxiliary electrical contacts for giving alarm in the event of the temperatures becoming excessive. The water discharged from the runner in a nearly vertical direction is led to the tail race through a bent concrete draught tube, the upper part of which is lined with sheet steel and close behind the bend there is a partition for the purpose of maintaining a proper linear motion of the water.

(To be continued.)

A 100-Ton Floating Dry Dock for Flying Boats.

TOWARDS the end of last year there was successfully launched from the yard of the Flewder Werken, at Lübeck, a 100-ton floating dry dock for the flying boats on the Lübeck-Travemünde service of the Deutsche Luft Hansa A.G. It is believed that this dock is the first of its type to be built, and the accompanying engraving, which shows the dock with a Dornier Superwal flying boat upon it, will, therefore, be of interest to our readers.

As our illustration shows, the dock comprises two parts, the forward part, which is left free to receive the flying boat or seaplane that it is desired to dry dock, and the after part, on either side of which the workshops, machinery rooms and staff accommodation are arranged. The usual moving bollards are fitted, and on either side of the dock is a derrick post and crane jib with lifting appliances for 4 and 2 tons. At the centre of the dock rails are laid to

FLOATING DRY DOCK FOR FLYING BOATS

take the wheels of a trolley, by the use of which the machine may be quickly transferred from the dock to the sheds. The following general method is followed in dry docking the machines. Before being anchored the dry dock is manœuvred into such a position—against the wind—that the flying boat can easily alight upon it. Before the machine actually alights the dock is submerged, and as soon as the boat is over the forward free part it is pumped out and, as shown in our illustration, the machine is raised clear of the water for examination of the under parts. When further repairs are necessary the flying boat is hauled into the sheds on the trolley. We are informed by the owners of the dock that it was launched from the builder's yard without difficulty, that it has proved satisfactory in service, and that the design has met all requirements. It is pointed out, however, that it may be expected that both the designers and the builders will be able to suggest still further improvements, which will prove useful to the growing development of sea flight.

The Boiler Explosion on the Clyde Turbine Steamer King George V.

WHEN reviewing in our issue of January 6th the progress made in steam marine engineering in 1927 we made brief reference to the mishap which took place on the Clyde passenger steamer "King George V." when, after a successful season's run, she was entering Irvine Harbour to be laid up for the winter. The accident took place shortly after midday on September 15th, when, owing to the formation of scale on the inside of one of the tubes, overheating and consequent rupture took place, which resulted in the severe scalding of two of the firemen, who later succumbed to their injuries. We have now received the report of the Board of Trade inquiry on this accident. A full description of the boiler will be found in THE ENGINEER for April 9th, 1926. The boiler affected was the forward one and it was designed to supply steam at 550 lb. pressure and was fitted with a superheater giving 750 deg. total steam temperature, being fired with coal by hand. In the course of his remarks the Board of Trade Surveyor notes that Greenock town water was used to make up losses in the feed tank, also that on an average 7 lb. of lime was put into the feed tank in the form of lime water each week the vessel was on service. The operating conditions of the vessel are described and an account is given of the circumstances attending the accident and the state of the boiler as inspected after the accident. The Surveyor goes on to say :—It was found that the fifth tube from the after end of the boiler connecting the steam drum to the right-hand water drum and in the row next the fire had ruptured longitudinally. The opening was 3ft. ½in. from the water drum and was in such a direction as to discharge the steam and water across the grate. The extent of the rupture was 4¾in. long and 1⅞in. maximum width. The tube, which originally had an outside diameter of 1¾in. and a thickness of 0·2in., had been forced back by the explosion against the tubes in the second row. The sixth tube in the first row was slightly bulged in two places, while a number of the tubes at the after end of the row drooped towards the fire. As the fire doors were in good working order prior to the explosion it is probable that No. 2 door had not been properly secured after firing. Had it been secured the two men would not have sustained such severe injuries.

An internal examination of the boiler was subsequently made. There was a considerable amount of soft scale on the water side of the fire row of tubes connecting the steam drum to the right-hand water drum. This varied in thickness, there being more deposit on the tubes at the after end of the row. It appears that in order to keep the fire of even thickness, more coal had to be put on the back end of the furnace, and consequently evaporation and therefore scale deposit would be greater at the back end. It follows that risk of overheating would be greater at that end of the fire row. This was borne out by the quantity of deposit inside the tubes and by their external appearance.

The banks of tubes connecting the water drums to the steam drum were free from any deposit apart from the preservative which had been used at the commencement of the season.

The tube which ruptured was enlarged over a length of 2ft. 6in., which length was in the zone of the flame and gases on their way to the uptake. The tube had expanded over a considerable length, and this expansion must have taken place previously in one or more stages. Subsequent local overheating due to an excessive accumulation of scale at this point caused the tube to bulge and finally fracture. That the overheating had taken place on more than one occasion is indicated by the portions of thick scale which were found to adhere to scale which had formed at a later period. It has been previously stated that the back end of the boiler had to be more heavily fired than the front end in order to maintain an even thickness of fire. Should the fire become thin the flame at this part would be intensely hot, with the result that there would be localised overheating. This, coupled with the presence of scale in the tubes, would account for the thinning of the tube. That the temperature of the material of the tube was at least 1000 deg. Cent. was shown by a micro section taken from the fractured edge. This showed a structure associated with quenching from high temperatures. At such temperatures the tenacity and elasticity of the material would be so reduced that the tube could not withstand the pressure and therefore fractured.

The row of tubes nearest the fire in the right-hand water drum is being renewed. Steps are also being taken to supply the boilers with pure distilled water only and the use of lime is to be discontinued.

In his observations the Engineer Surveyor-in-Chief says :—Cylindrical multitubular boilers working at moderate pressures have been almost exclusively used in merchant steamships, but in recent years conditions have changed, so that it has become necessary to provide for the generation of highly superheated steam at greatly increased pressures. A number of new steamships have, therefore, been fitted with high-pressure water-tube boilers, and this type of boiler may in future be more largely used in merchant ships.

In any type of boiler it is essential that, to avoid corrosion and fouling of the heating surfaces by scale, the feed water should be pure. In seagoing steamships, if there were no loss of feed water by leakage, the question of scale would present little difficulty. Unfortunately, there are always losses, and in the present case water obtained from town mains was used to supplement the feed from the condensers. The water was presumably of good quality, but hard, and no other treatment was considered necessary than the mixing of lime with the feed water. With boilers of the ordinary marine or Scotch type no exception could reasonably be taken to the methods used in dealing with the feed water, as in such boilers a proportion of the soluble matter in the feed water would probably have been precipitated to the comparatively quiescent water at the bottom of the boiler, and any scale formed would have been distributed more or less uniformly over the heating surfaces. In a water-tube boiler, especially in one of a small-tube type, the water is in continual and rapid movement so that there is less chance of solid matter being deposited as sludge : also, owing to the heavy evaporation in the tubes near the fire, a large proportion of the scale is formed in those tubes, and even when the feed water is, when judged by old standards, comparatively pure, a thick layer of scale may be rapidly formed, causing overheating and distortion. It is clear, therefore, that only distilled water should be used in high-pressure water-tube boilers, and in this vessel an evaporator was fitted, so that the desirable degree of purity could have been obtained by distillation of the town water. Such boilers should not be closed up after cleaning before it has been ascertained by inspection that every tube is clear and perfectly clean.

Unfortunately, in this case the tube failed while a fire door was open and two firemen were directly exposed to the explosion. The engineers acted with promptitude and apparently did all that was possible in difficult circumstances. The owners are now arranging for the use of distilled water only for feed make-up.

Railway Matters.

THE hotel and refreshment rooms receipts of railway companies are, of course, adversely affected by the fall in the number of passengers. The London, Midland and Scottish Company, for instance, lost £66,000 in that direction last year, as compared with 1926.

IT is stated that it is proposed to run the Highland night express from Crewe to Perth without a stop. As the distance is 8 miles shorter than the 299 miles non-stop run between Euston and Carlisle, there seems no reason why the proposal should not be put into effect.

THE Joint Committee of the Lords and Commons that will inquire into the railways' road transport Bills will consist of five members from each House. It will meet for the first time on Monday, March 26th, and, as the inquiry will be a long one, will sit daily on five days a week.

ANSWERING a question recently as to railway level crossings, Colonel Ashley said that, with assistance from the Road Fund, sixteen bridges had been, or were being, built, in order to abolish existing level crossings, and that negotiations as to ten other important crossings were in hand.

MENTION was made in our last two annual articles on Railway Engineering of the changes being made by the London and North-Eastern Railway at Frodingham in connection with the ironstone traffic. The extensions include an improved passenger station which was brought into use on March 11th.

TRESPASSING on the railway is an unlawful and dangerous act, but when the railway is electrically operated the danger, because of the live rails, is much greater. It is satisfactory, then, to hear that the Southern Railway Company recently successfully took criminal proceedings against a man who walked along the line from a level crossing to the station. The defendant had previously been warned.

IT was announced on Tuesday that the "River" class locomotives on the Southern Railway are to be fitted with tenders. This is the type concerned in the derailments of March 31st, August 20th and August 24th, at Wrotham, Bearsted and Sevenoaks respectively on that system, and the class was withdrawn from service temporarily after the last-named accident. The change is not being made as a consequence of anything said concerning the engines in the reports by Lieut.-Colonel Mount or Colonel Sir John Pringle on those accidents. In future the engines will form the "U" class.

IT is officially announced that the directors of the Great Southern Railways of Ireland have promoted the secretary of the company, Mr. C. E. Riley, to the position of general manager, vacant on May 1st by the retirement of Mr. M. F. Keogh. At the annual meeting of the proprietors the other day, the chairman, referring to Mr. Keogh's resignation, said that by the exercise of great tact, combined with organising ability of a high order, the Irish amalgamation was brought into operation under his supervision in a shorter time and with much less dislocation than could have been anticipated by its most ardent advocates.

FURTHER evidence of the happier relations which now exist between the railway companies and their men was furnished by the appearance of Mr. J. H. Thomas, the men's leader, and Mr. J. H. Follows, a vice-president of the London, Midland and Scottish Railway, on the same platform at a meeting of railwaymen on a recent Sunday evening. Mr. Follows, referring to the advantages now being given to railwaymen in Germany, said that he wanted to make it possible for young men of ability in every grade in the railway service of this country to rise to the highest administrative positions. That could be done by giving the sons of engine-drivers, shunters and signalmen opportunities for technical and specialised education.

ACCORDING to the Board of Trade returns, the value of the railway material exported during the first month of the present year was as follows; the corresponding figures for 1927 and 1926 are added in brackets:—Locomotives, £172,385 (£75,298, £383,866); rails, £364,473 (£38,227, £188,228); carriages, £628,864 (£217,923, £131,064); wagons, £259,715 (£168,269, £385,338); tires and axles, £60,783 (£25,916, £22,507); wheels and axles, £109,867 (£30,026, £33,210); chairs and metal sleepers, £93,080 (£8589, £80,053); miscellaneous permanent way, £74,608 (£90,368, £85,962); total permanent way, £708,982 (£209,953, £432,492). The weight of the rails exported was 43,659 tons (1811 tons, 23,816 tons), and of the chairs and metal sleepers, 9785 tons (865 tons, 7959 tons). Locomotives to the value of £101,572 were shipped to India and rails to the value of £139,071 to the Argentine and £103,146 to India.

THE preliminary report of the Canadian National Railways for 1927, presented to Parliament on March 6th, showed that the operating revenue was 256,575,724 dollars, and that the operating expenses amounted to 214,461,747 dollars, leaving a net operating profit of 42,113,976 dollars. That figure, while about 6,000,000 dollars less than the net earnings of the previous year, is more than sufficient to pay the interest, amounting to 40,448,274 dollars, due to the public investors. The reduction in net earnings, the report states, is due to two major factors, the reduction of the grain freight rates on the western section, which decreased the freight revenue by 652,550 dollars, and the increase rates of pay and changes in the working conditions under the various wage agreements. The latter is estimated to have added 3,771,000 dollars to the operating expenses for the year. Additional labour employed, which cost 579,000 dollars, and increased charges other than direct labour for maintenance and operation, which cost 4,639,000 dollars, made up the remainder of the increase in operating expenses. A deficit on the operation of the Eastern lines amounting to 3,264,695 dollars will be made good by the Government in accordance with the legislation which reduced the freight rates by 20 per cent. The operations of the Vermont Central are not included in the report, as the line is in the hands of a receiver, and heavy expenditures will be required to repair the damage caused by floods. During the year there were new issues of bonds increasing the funded debt held by the public by 55,901,492 dollars.

Notes and Memoranda.

ACCORDING to Dr. Hans Merensky, South Africa, "with its resources of the cheapest coal in the world, should be able to command mechanical power on a vast scale for agriculture and industries generally."

THE new St. James Power Station at Singapore includes three main turbo-alternators of 5000 kW each, another of 2000 kW, and a geared auxiliary set of 120 kW. Current is generated at 6600 volts 50 cycles. The boilers are oil-fired and work at a pressure of 250 lb. per square inch.

AMONG the many methods of electrical prospecting widely used in Canada from which interesting results have been obtained is that known as the Radiore process, a high frequency method. It has been much used in the Rouyn District of Quebec for the purpose of mapping the sulphide areas on various properties.

IN an article on the manufacture of a new form of levelling rod, in the *Engineering News-Record*, Mr. D. L. Parkhurst says that, to prevent swelling, the wooden back was formerly immersed in boiling paraffin, but this was found to add materially to the weight and to destroy the resilience of the wood to such an extent that the parts frequently took a permanent set. It is now treated by applying a heavy coat of raw linseed oil, three coats of orange shellac and two coats of white lead paint. This treatment furnishes excellent protection against moisture and in no way affects the resilience.

DIRECTIONS for the use of the iodine pentoxide detector in determining the amount of carbon monoxide in mine air have been prepared by the United States Bureau of Mines. Various methods are used by the Bureau for determining the presence of carbon monoxide in mine air, but the underground use of the pyrotannic acid method, for instance, is somewhat restricted by its limitation to air containing not over 0·2 per cent. of carbon monoxide. The iodine-pentoxide hoolamite method, however, permits the use of a detector which readily and simply determines the amount of carbon monoxide in mine air.

A WARNING against the casual application of a piece of apparatus, which if handled properly is quite safe, is sounded in the report on the explosion of a kier in a bleaching works at Eccles, which, unfortunately, resulted in the death of two men. The kier was being warmed up by steam to dry the lagging. It had a lid fixed by a form of bayonet joint. The holding-down lugs of the lid were only partially engaged, as it was not anticipated that any pressure would be raised within the kier. Pressure evidently did, however, accumulate, the lugs slipped out of their fastenings and the lid of the kier was blown off with disastrous results.

THE danger of working a boiler without adequate supervision is well exemplified in a recent report on the explosion of a semi-portable boiler on a Huntingdonshire farm. The boiler was about forty-four years old and the failure was caused by one of the fire tubes collapsing. Fortunately, no one was injured. In the words of the Commissioners, the attendant on the boiler "is in no sense a qualified engineer, not having served apprenticeship, though he appears familiar with agricultural machinery. No one was called in to examine the boiler and engine. It should have been well known to everyone that this boiler, already very old, must have further deteriorated during the period of idleness."

IN the winter and spring of 1878, in the Hall of the Franklin Institute of Philadelphia, competitive dynamo tests were carried out by Professor Elihu Thomson and Professor E. J. Houston. The tests were made on various types of dynamos in order to determine which was the most efficient. As a result of them, a Brush arc light generator was recommended for purchase by the Franklin Institute. A celebration of the semi-centennial of these tests will be held in the Franklin Institute on the afternoon of Wednesday, April 18th, in the Hall of the Institute, when papers will be presented by Dr. Elihu Thomson, the survivor of the two men who made the tests, and by Dr. Charles F. Brush, the man who invented the type of dynamo finally recommended.

IN a paper read before the Boston Society of Civil Engineers, Mr. C. W. Babcock described how the worn cast iron casing of a water wheel, 6ft. in diameter, was mended by electric arc welding. The patching had to be built up to a depth of about 1in. and was started by welding in place a number of steel hoops from ¼in. to ⅜in. in diameter. The remaining space was then filled in by welding. While welding directly on the cast iron the welder ran a bead of only 1in. or 2in. at a time on one spot, and a helper then immediately peened this with a hammer to stretch it and avoid porosity as much as possible. The first layer of welding to the cast iron was done with a special grade of welding wire for cast iron. Succeeding layers were put on with ordinary steel welding wire. After the welding operation was finished a portable grinding wheel was rigged up and the high spots ground off the welded section.

AN article in the *Electric Journal* describes the process of manufacturing steam turbine spindles adopted by the Westinghouse Company of America. In this article it is explained that after a spindle has been balanced it is placed in a heater box and subjected, while running, to a heat treatment, which seasons the spindle and relieves the remaining stresses to a very great extent. The process is as follows:—The spindle is placed in an iron casing somewhat similar to a turbine cylinder. Here it is revolved in its own bearings by a small turbine at a speed of from 100 to 500 r.p.m. for a period of two hours. The exhaust of the heater box is then opened to the atmosphere, and saturated steam is admitted at an approximate rate of 10,000 lb. per hour for a period of two hours. At the end of the two hours the steam is gradually superheated, raising the temperature slowly and uniformly throughout a period of six hours to a maximum of 700 deg. Fah. at the exhaust of the heater box while maintaining a flow of approximately 10,000 lb. per hour. The rotor during this time is still rotating at a speed of 100 to 500 r.p.m. Following the heating-up process the overspeed tests and final heat treating are respectively carried out, whereupon the spindle is again tested for balance either in the balancing machine or in the heater box.

Miscellanea.

IT is proposed to construct a transporter bridge across the river Yarra at Williamstown, Victoria.

A CEMENT works is to be put up at Linchow, in the Kwangsi Province of China, at a cost of about £40,000.

THE Commercial Exhibition which was to have been held in Pekin this spring, has been postponed to the autumn.

A COMPANY has been formed in Stockholm, with a capital of 24 million kroner, for the direct production of iron, steel and non-rusting iron by the Flodin electric furnace process.

THE Ontario Hydro-electric Commission is embarking on the erection of 1050 miles of rural transmission line. The work will cost about 2,500,000 dollars, and will serve some 6600 consumers.

THOUGH the total value of timber products in British Columbia in 1927 was a little lower than that of 1926, exports of lumber reached a new high figure. The aggregate was 740,230,000ft., an increase of 27,500,000ft.

A MOTOR tug which has recently been put into service by the Cochin Harbour Board is 40ft. long by 9ft. beam, and 2ft. 10in. draught. She is equipped with a 28–36 H.P. six-cylinder engine by the Ailsa Craig Company, of Chiswick.

THERE has just been published by H.M. Stationery Office, at the price of 9d. net, a booklet containing a large series of abstracts from journals all over the world dealing with the science of building in stone, metal, and concrete.

ON account of the fact that the principal thoroughfares of Pekin are to be coated with asphalt, the Metropolitan Municipal Bureau has decreed that the narrow-tired old-style carts must have new wheels. The report does not indicate the type required.

THERE are, according to the *Iron and Coal Trades Review*, good prospects of the extensive deposits of rich iron ore at Yampi Sound, in Western Australia, being worked with British capital at an early date. Negotiations for the shipment of 150,000 tons of ore annually to Japan are proceeding between Japanese interests and the holder of the option over the Koolan Island leases in the Sound.

IN addition to the short-wave wireless station recently built at Nanchang, Kiangsi, China, the authorities are contemplating the construction of a broadcasting station there and the installation of receiving sets in all *hsien* districts in the province, so that lectures and news may be broadcast from the capital to the whole province. A short-wave wireless station has also been built at Kiukiang, Kiangsi Province, for military use.

THE Royal Agricultural Society of England has issued its prize list for live stock, poultry, produce and implements in connection with the forthcoming Show, which is to be held at Nottingham from July 10th to 14th next. The sum of £14,633 is to be offered in prizes, the major portion of which will be allotted to the cattle section. The Nottingham Local Committee is contributing £1454 to this fund. In the implement section there will be the usual awards of silver medals by the Society for new inventions, and entry forms can be obtained of the secretary, 16, Bedford-square, London, W.C. 1.

A NEW short-wave, high-power wireless valve, developed by the General Electric Company of America, comprises a vacuum tube, 5in. in diameter and about 2ft. long. It is set in a wooden cage, surrounded by wires, condensers, and electric meters. It operates as a self-excited oscillator on a 6 m. wave length, and is capable of radiating from 10 to 15 kilowatts of high-frequency power, or about fifty times as much as any other short-wave tube has been known to produce. The valve is connected through a coupling system to a copper bar, about 10ft. long, which is able to radiate into space the full 15 kilowatts generated by the oscillator.

WATER supply from the new plant of the Chapei Electricity and Waterworks Company, Ltd., at Dike-road, Military-road, Chapei, Shanghai, was begun on February 15th, 1928. Construction of the new plant started in August, 1926, and the cost has been about £200,000. The plant is capable of supplying water at the rate of 12 million gallons every twenty-four hours. The water is drawn from the Whangpoo River instead of the Soochow Creek, which was formerly the source of supply. The new plant possesses the following features:—(1) Two coagulation basins, twelve rapid sand filters, and two chlorinators, the combined capacity of which is 12 million gallons; (2) one pump house equipped with a centrifugal pump driven by motor with 1000-kilowatt power and with a water pressure equivalent to 100 lb. to the square inch at the works and 40 lb. per square inch for hydrants; (3) five purified water reservoirs with a capacity of 957,000 gallons; (4) a water tower 95·5ft. high with a capacity of 170,000 gallons; and (5) water mains consisting of C.I. pipes, 36in. in diameter, which are connected with the old distribution system and aggregate a total length of 7·5 miles.

A NEW waterworks scheme for Lahore has been proposed by the Government Sanitary Executive Engineer, Mr. Howell. He explained to the Municipal Committee at a meeting recently that the existing water supply was installed at a cost of Rs. 15 lakhs in 1884, and had done good work, but was now absolutely inadequate. For the new supply, two alternative schemes had been considered—tube wells or direct Ravi supply. Government engineers did not favour tube wells, as their life was only ten years or less in Lahore. The other scheme was for pumping direct to Lahore from the headworks on the Ravi near the railway bridge. The site was safe from floods. The old reservoir would be retained for the city only and a new reservoir constructed outside the Bhati Gate to supply the civil station through three mains. The design is for 30 gallons per head of the present population, but capable of expansion for increase of population after completion in 1931. The supply is to be continuous for twenty-four hours and the pressure will ensure the highest levels being commanded. The Government had suggested that power should be obtained from the Mandi hydro-electric station when available.

HYDRO-ELECTRIC DEVELOPMENTS IN THE PROVINCE OF QUEBEC

(For description see page 313)

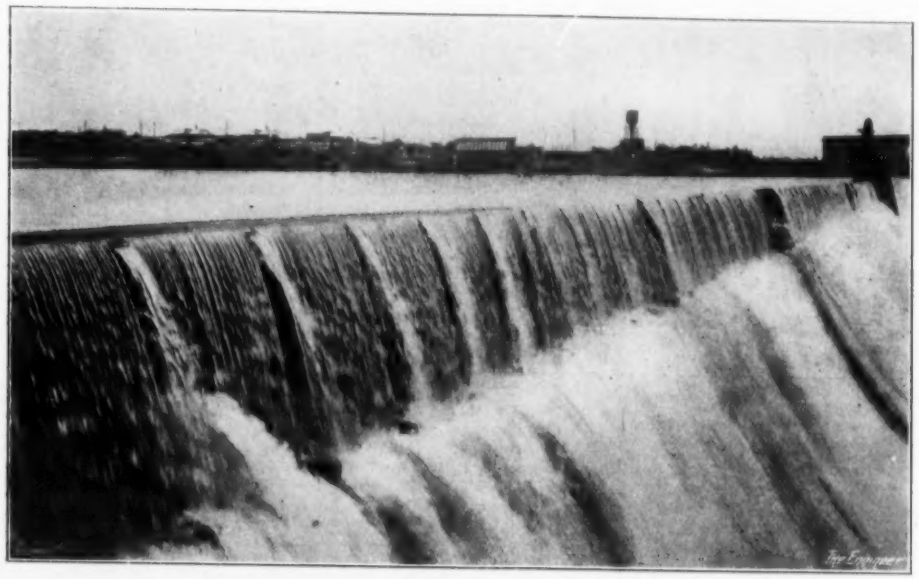


FIG. 1—SPILLWAY AT CHUTE-AUX-GALETS POWER-HOUSE ON THE SHIPSHAW RIVER

FIG. 2—DRUMMONDVILLE POWER-HOUSE ON THE ST. FRANCIS RIVER

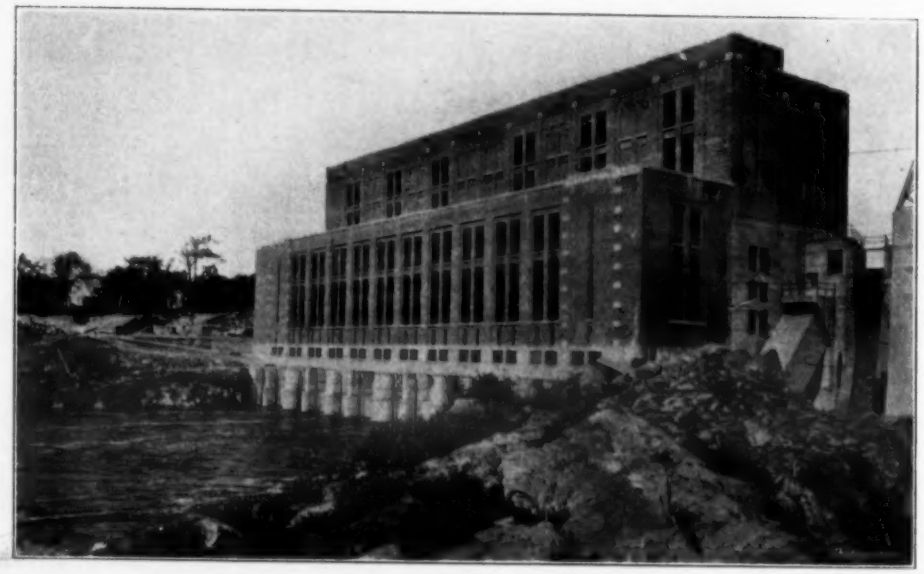


FIG. 3—HEMMINGS FALLS POWER-HOUSE ON THE ST. FRANCIS RIVER

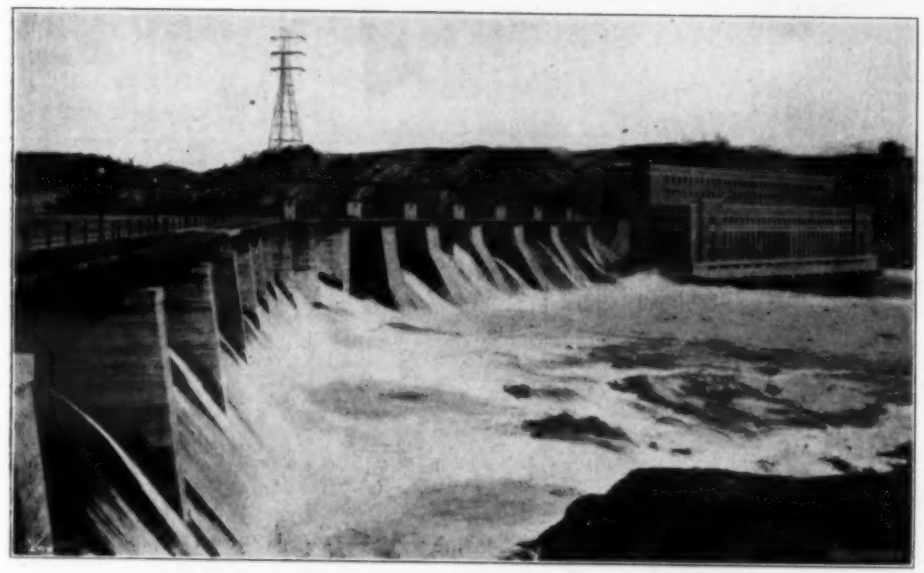


FIG. 4—LA GABELLE POWER-HOUSE ON THE ST. MAURICE RIVER

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THE ENGINEER.

MARCH 23, 1928.

Locomotive Testing Plants.

THERE can be no doubt that the plea for the construction of a locomotive testing house in this country which was made by Mr. Gresley in his presidential address to the Institution of Locomotive Engineers is beginning to receive the attention which it undoubtedly deserves. At nearly every meeting where locomotives are discussed some reference is made to it, and opinion, which for many years has been luke-warm or indifferent, is at length becoming decidedly in favour of the construction of a plant—or even plants—of the kind. It is indeed an anomalous thing that a country which is not only the home of the locomotive, but has a very dense railway system of its own and supplies locomotives to the railways of many other countries, should have no means of carrying out scientific tests of its products. The studies made at the Altoona plant of the Pennsylvania Railroad are known all over the world, and their influence upon the locomotive trade of America can scarcely be negligible. In these days when "Science" permeates all things, much effect is made upon the minds of potential buyers by the presentation of arguments in a scientific form. Over and over again we have seen British inventions taken up, after years of neglect, by some foreign professor or scientist and returned to this country with all the panoply of scientific treatment. People whom it was impossible to convince by the simple statement of practical results were impressed by the detailed scientific treatment, and our own inventions were acquired under licence for our own use from foreigners who had taken the trouble to robe them in scientific garments. It may be said that locomotives are not like many other machines, and that they are bought under expert advice which is not likely to be impressed by anything less than solid economic facts. That is, in some measure, true. But it is, at least equally, true that the scientific presentment of facts is now very commonly expected, and that it does carry weight, even with experienced purchasers.

For these reasons we anticipate that the existence of a "commercial" testing plant for locomotives would be of direct benefit to our overseas trade. If, however, we regard the matter from the point of view of the railways, it is seen in another light. Speaking in the discussion on Captain Beames' paper at the meeting of the Institution of Mechanical Engineers on Friday last Sir John Aspinall urged each of the four great companies to lay down a testing plant of its own. He pointed out that the London, Midland and Scottish Railway owns something like 10,000 locomotives, upon which it has to spend annually, in round numbers, £5,000,000 for repairs and renewals. Its fuel bill is also approximately £5,000,000. Thus on these two items alone the company disburses £10,000,000 per year. The cost of building, maintaining and operating a testing plant would be insignificant by comparison with these figures, and the savings that it could effect by what might be in itself a trifling economy would do far more than meet the cost. Consider, for example, a single item like the consumption of lubricating oil by locomotives. On the L.M.S. the bill is £150,000 per year, and on the L. and N.E.R. £105,000. Much of the oil is wasted, as anyone may satisfy himself by examining the ballast over which engines have stood for any time. By a reduction of no more than 5 per cent. in its consumption of oil, the L.M.S. Railway could save £7500 per year—more than enough to support a testing plant. On that railway—we quote again from Sir John—five thousand locomotives are repaired each year. There are no means of testing those engines after repairs, just as there are no means of testing new engines, save taking them for short runs, and, in exceptional cases, attaching them to dynamometer cars. Even a rapid, routine test would certainly reveal differences in the performance of the engines of any given class, and the savings that might be effected by bringing the worst up to the level of the best, and making the best better, would result in a very large, possibly an enormous annual saving. Defects can, of course, be detected in service, but money has been wasted before they are found out and removed, and there are defects of certain kinds—let us say rather, openings for improvement—which, owing to the difficulties of testing locomotives on the road; could only be discovered by scientific methods conducted in a properly fitted test house. If we turn from engines in service to the development of new types, the need for all the appliances that science can suggest for complete tests is even stronger. When a new engine is designed it goes on the road. A few runs are made with a dynamometer car, and then it is put into service for a few months, its performance, in all respects, being carefully watched. If it performs the duties demanded of it by the traffic department, if it is free from mechanical defects and is reasonably economical, several are built from the same drawings. The real test is a service test; an admirable one; yet one that leaves the engineer in doubt about many things because he has no means of measuring them. Were it possible to put the first engine on the test bed, and examine it in full detail, it is far from improbable that in nine cases out of ten means of making small improvements would be at once detected, and could be incorporated in the design before other engines were built. Then there is the problem of locomotive accessories of all kinds. The final word on all such things must come from the running department. But much might be learnt about them by stationary tests carried out under scientific conditions. It must be remembered that the search is not so often for great economies that leap to the eye as for an accumulation of small savings which can only be detected and made available by precise measurements.

Sir John Aspinall, as we have said, advocated the possession of a locomotive testing plant by each of the railways, but there is a good deal to be said in favour of a national testing plant which would be open to all, and which, moreover, could carry out, from time to time, independent inquiries. We agree entirely with Sir John that the companies could well afford to build and maintain their own plants—the Great Western already has one, but we are unable to say how much it is used—and we agree with him that much very useful routine testing could be done upon them. But it is hardly likely that the companies would allow private tests to be carried out on their plants. A national plant, such as that advocated by Mr. Gresley, would be available to all, and would be operated by a staff of scientists as independent as that of the National Physical Laboratory. On it not only could new engines of the companies or of builders be tested, but valuable scientific inquiries into questions common to all locomotives could from time to time be conducted. There can, we

believe, be no doubt at all that results which are now obtained only after months on the road could be obtained in a few days, and that in the aggregate enormous sums could be saved. Moreover, such a plant would provide facilities for testing entirely new developments in locomotive design—steam, electric, oil or what-not—and so do not a little to encourage invention.

The Central England Electricity Scheme.

The third of the national electricity schemes has just been issued by the Electricity Commissioners, who, we believe, originally hoped to be in a position to present it before the close of last year. It relates to Central England and embraces an area of 7311 square miles, and from it about 5,218,146 people are expected to derive benefit. Whether the opposition to the previous scheme took up so much of the Commissioners' time that they were unable to deal with this third undertaking we do not know, but the fact remains that whilst the proposals for Central England were expected last November, they have only just been issued. The counties affected are Leicester, Northampton, Stafford, Warwick, and Worcester, large portions of the counties of Derby, Nottingham and Salop, and portions of the neighbouring counties of Bedford, Buckingham, Chester, Gloucester, and Oxford. The area extends from Stoke-upon-Trent and Mansfield in the north to Buckingham and Tewkesbury in the south, and from Newark and Higham Ferrers in the east to Shrewsbury and the Welsh border on the west, and it contains the important industrial regions around Birmingham. It embraces the West Midlands, the South-West Midlands and the East Midlands Electricity Districts, as well as the North-West Midlands Electricity District, as provisionally determined by the Commissioners and for which the formation of a Joint Electricity Authority is contemplated. The whole or the major portion of the area of supply of forty-nine authorised undertakers falling mainly within the boundaries of the three existing Electricity Districts mentioned come within the scope of the scheme. The greater part of the area is within the statutory limits of existing organisations—a Joint Electricity Authority and three power companies—having rights to supply in bulk and otherwise over wide tracts of country, and with these organisations and other owners of selected stations the primary transmission system will mainly deal.

At present the agricultural districts in the eastern, south-western and western parts of the Central England area are for the most part unprovided with any system of supply, but the operations of the West Midlands Joint Electricity Authority and the proposals adumbrated in the case of the North-West Midlands Electricity District should go a long way towards securing the electrical development of the western parts of the area, when assisted by the transmission system of the Central Board. The rapid extension of high-tension lines now being carried out by the Shropshire, Worcestershire and Staffordshire Electric Power Company, the Derbyshire and Nottinghamshire Electric Power Company, and the Leicestershire and Warwickshire Company, and the distribution developments in progress or contemplated by those companies and other undertakers will tend to meet the needs of the rural districts in the south-western and eastern portions of the area. The transmission system of the Central Board is expected to prove of material assistance and to reduce the cost of the secondary transmission developments of the undertakers concerned by providing additional feeding-in points. Other schemes will deal with districts which surround the Central England area and the transmission lines provided for by the present scheme will eventually be joined up with similar lines in the surrounding areas so as to form one comprehensive system. Nineteen stations out of the forty-six now in operation or authorised are to fall under the scheme, which also provides for working six additional existing stations temporarily. By the collective operation of these twenty-five stations the needs of Central England will be met, whilst the growing load will be dealt with by concentrating the base loads as far as practicable on four of the principal stations, namely, Hams Hall, Ironbridge, North Wilford, and Stourport, and by utilising a gradually reducing number of other stations for peak load purposes. Three of these stations are situated on rivers, the Severn and the Trent, and all four are within easy reach of several coalfields. Sources of waste heat in various parts of the area are to be made use of when the Board's transmission system has been established. The cost of the primary transmission system and transforming stations, after allowing for the capitalisation of interest during the first five years, is estimated to amount to £3,640,698.

By leaving out of the South-East England scheme certain large traction stations that do not generate at the standard frequency the Electricity Commissioners were able to draw up that scheme without making any allowance in the estimates for the standardisation of frequency, but in the present case the conditions are very different. Like the Scottish scheme, the present scheme introduces considerable difficulties in this direction, and it is well known that the Chief Electrical Engineer at Birmingham has opposed the proposal to standardise frequency in that part. In order to meet the views of the engineers of the Birmingham Corporation and the Shropshire, Worcestershire, and Staffordshire Electric Power Company it is proposed that no further 25-cycle generating plant beyond that already sanctioned shall be installed in the area of supply of either of the undertakings. Any development of 25-cycle supplies must be limited to the safe output of the 25-cycle plant at the generating stations at Nechells, Summer-lane, and Smethwick. All other parts of the systems of the two undertakers in question, including the plant in the generating stations at Hams Hall and Stourport, is to be gradually changed over in appropriate and convenient sections to the standard frequency of 50 cycles per second. The change over in the case of the heavier-loaded centres, which will be supplied for the time being at 25 cycles per second, will be effected as and when circumstances render it desirable in accordance with a programme arranged so as to avoid any dislocation of the industries which are being supplied at the non-standard frequency.

It appears that the standardisation of frequency in Birmingham will be a very slow process, and it remains to be seen if complete uniformity will ever be brought about. We note that a 5000-kW frequency changer is being installed in the Stourport station, which is not exactly a good step in the direction of saving plant or of reducing losses; but no doubt this machine will be put out of action in due course. Much of the work in the Birmingham Corporation's area, it is stated, will be rendered easier by reason of the existence of extensive direct-current networks supplied from rotary or mercury vapour rectifier sub-stations. So far as such networks are concerned, no alteration will be required to the distribution system itself. The process of standardising the frequency will, nevertheless, involve scrapping a lot of costly converting plant, although the rectifiers can be retained. But as the rectifiers were installed for the purpose of avoiding the use of 25-cycle current for lighting in private houses we see no justification for their existence when this frequency is abolished. The estimated cost of standardising the frequency in the South West Midlands District is £2,061,400, but Mr. Chattock has estimated the cost for Birmingham alone to be very much more than that. It is expected that there will be a progressive decrease in the average cost of the supply offered by the Central Board to authorised undertakers from 0·495d. per unit in 1930–31 to 0·426d. per unit in 1934–35. Let us hope that all the good things the Commissioners expect from the scheme will be realised. But as we have said before, the problems and difficulties associated with all these schemes will be better understood as the work progresses, and original ideas may have to be modified.

Levelling with an Aneroid.

By Colonel Sir GORDON HEARN, C.I.E., D.S.O., Royal Engineers (Retired).

No. III. (*Conclusion*).*

In the last article the theory of calculation of heights from differences of pressure, corrected for temperature, was examined. It is necessary, however, to make corrections for variations of the pressure during the time which elapses between observations, apart from the difference of pressure due to difference in height. These variations may be due to the arrival or passing away of a storm, but in the Tropics there is a diurnal wave of alteration of pressure of quite important dimensions. In the British Isles the variation is small, and the intensity of storms so great that the diurnal wave is obscured by the abnormal variations and receives little attention in text-books.

Sir John Herschel records that this phenomenon was observed so long ago as 1666 by Dr. Beale in England, and the double wave, by day and by night, was observed in 1682 at Goree in French Senegal. Mr. T. G. Gribble, writing on "Diurnal Variation" in Vol. 171, "Min. Procs.," Inst. C.E., stated that hourly readings of the barometer had been taken at Batavia in Java for over forty years. The wave is being automatically recorded at certain stations in India, but it is believed that analysis has not yet been made. The writer has made a long series of observations, and will now analyse them. They are at the disposal of anyone interested.

His records consist of:—

(*a*) A practically continuous wave from September 1st, 1919, to July 24th, 1920, at Peshawar in the North-West of India, showing also maxima and minima temperatures, periods of cloud obscuration and rainfalls.

(*b*) A similar record extending from June 24th, 1921, to October 4th, 1922, at the same place.

(*c*) Simultaneous observations from July 1st to November 29th, 1921, at Landi Kotal.

(*d*) A record at Calcutta from November 20th, 1926, to March 30th, 1927.

The heights above sea level are about 70 at Calcutta, 1150 at Peshawar, and 3550 at Landi Kotal, which is 24 miles from Peshawar in a direct line. Three different aneroids were used, and a certain amount of index error may be suspected, but comparison was made of the Peshawar aneroid with the readings of the barometer at the meteorological stations there, reduced to M.S.L. in the weather charts, and the differences in index error over the whole period given in (*b*) were very small.

At some time between 8 a.m. and 11 a.m., depending on the season, pressure commences to fall until 4 p.m., or even as late as 7 p.m. in the afternoon. The pressure then rises until about 11 p.m., when a smaller fall of pressure occurs until about 4 a.m., and a further rise follows until the morning fall of pressure commences. The times and the amounts of the variations will be affected by depressions passing over, being "damped down" or accentuated as the case may be. This makes it most important to observe as continuously as possible while barometric levelling is in progress. The nightly fluctuation is not so important to the engineer, except as an indication of what may be expected on the following day, but an early morning start to observe is important. Unfortunately, the work will probably be begun before the morning fall has commenced, but a halt should be made about the expected time of that fall, and the aneroid watched for half an hour or more.

The records indicate the following times as probable in different months at the two stations following:—

	Calcutta. Fall. a.m.	Calcutta. Rise. p.m.	Peshawar. Fall. a.m.	Peshawar. Rise. p.m.
November	10	5	10	5
December	10	5	11	5
January	11	5	11	6
February	10	6	11	6
March	9	6	11	6
April			10	6
May			9	6
June			8	6
July			8	7
August			9	6
September			9	6
October			9	6

But there may be an appreciable pause at the end of the fall for an hour or two, and sometimes at the end of the rise in the morning. The duration of the fall may thus be from six to eleven hours.

The variation in pressure also depends on the time of year, as does the general level of pressure at the commencement of the fall, which was given in a table in the second article. The variation depends also on the latitude and on the altitude of the station.

In the United States of America the variation is said to be from ·04 to ·12. Kaemtz at Leh observed ·17, which is supposed to have included a proportion of abnormal variation owing to a depression. At Calcutta it is given as ·14 in April and May, but only ·09 in July. In the British Isles it is stated at ·02 on the average. Mr. Gribble infers from his observations in Java that the diurnal wave there ceases to be felt at an altitude of 8200ft., but the writer has observed the wave at Simla, 7500ft. Mr. Gribble, moreover, in a footnote states that the wave at Dodabetta Peak in Southern India, 8630ft. above M.S.L., was ·06in., while at Madras the range was ·082in.

In the writer's Peshawar observations, the abnormal variations were so frequent that it is difficult to distinguish a seasonal alteration in the range of the diurnal wave, for which ·14 is a fair figure. But on one occasion the range was ·24in., without a sign of abnormal variation. At Landi Kotal, higher by 2400ft., the range was smaller, about ·08 on the average over the four months of observation. This shows that if there is much difference between a station, where a stationary instrument is kept for recording the wave while the operations are conducted in the field, the diurnal wave at the lower station will not be a true indication for purposes of correction. The point is dealt with again later.

At Calcutta, the writer did not find such violent abnormal variations. The range was ·12 from November to February, rising to ·15 in March.

* No. II. appeared March 16th.

Occasional storms did increase or decrease the range.

The necessity for correction for the diurnal wave is clear, for, if an hour elapses between observations at two stations, the second reading may be too low by ·02in., equivalent to 20ft., or more if corrected for a high temperature. If an abnormal variation be in progress at the same time, a further element of error, increased by temperature addition, will be introduced. It will hardly be possible to do more than estimate the correction, but even this reduces errors.

The recording of cloud and rainfall in the writer's observations leads him to offer the following hints for probable effects.

Cloudy weather in the cold season causes both maxima and minima temperatures to increase, and the barometer to fall. In the hot season it has little effect on minima, but maxima temperatures are not so high, the effect on the barometer being slight. If rain falls, both maxima and minima temperatures are decreased, and a rise of pressure, sometimes very sharp follows, although in the cold season it may not occur for twenty-four or even forty-eight hours.

An attempt to correlate maxima and minima temperatures with ranges of the diurnal wave has been unsuccessful. If both are high, the range is slightly increased, but the general level of pressure is the more affected. Of course, depressions passing over may have their effect, but their action is confined to the lower strata of the atmosphere, which throughout its great thickness ought not to be greatly affected.

The diagram shows pressures at Peshawar and Landi Kotal simultaneously, with maxima and minima temperatures at Peshawar. If the temperature record be inverted it shows a remarkable resemblance to the barometer records, which show the levels at the commencement of the morning falls.

So far, the orthodox theory has been followed, that pressure decreases with height by a logarithmic formula for a given temperature, and that a correction is necessary for expansion of the air, taking the mean temperature at the two stations. The writer has had doubts whether a theory applicable to a column of air above a point at M.S.L. is really applicable to a shorter column above a point or two points some distance apart on higher ground, and heated ground. But an examination of the simultaneous readings at Peshawar and Landi Kotal shows remarkable corroboration of the theory.

The difference of altitude being constant, the difference of pressure should be greater for a low temperature than for a high temperature. Taking the peaks of the diurnal waves recorded at the two stations, we find that a lower minimum induces a greater difference, while, taking the hollows we find a smaller difference, due to the higher temperatures prevailing in the afternoons, and a still smaller difference if the temperature is very high; and maxima of 121 deg. Fah. in the shade were recorded on three successive days in July, 1921. The differing index errors of the instruments render it impossible to calculate whether the pressures corrected for temperatures agreed, but the general accuracy of the theory is borne out. Two examples are given :—

Date.	Temperatures. Min.	Max.	Pressure difference. Peak.	Hollow.
July 8th	86 ..	121 ..	2·13 ..	2·10
November 24th	46 ..	68 ..	2·54 ..	2·46

The minimum, moreover, is not the temperature at the time of the peak, which, as mentioned, varies, but occurs always some hours after sunrise. Nor is the maximum necessarily the temperature at the time of the afternoon rise of pressure. Temperatures are more likely to agree in winter than in summer.

The explanation of the diurnal wave is probably that the troposphere behaves like a faulty tube on a motor car wheel, developing a bulge, which is restrained by the stratosphere, representing the outer tyre. The bulge has to flow sideways and circumferentially, and the air in the troposphere flows towards the poles and also along the equator. Atmosphere charts in the "Dictionary of Applied Physics" show a relatively low pressure area at the surface in July over India, Persia and North Africa, while at 8 kiloms. (say, 25,000ft.) above the surface pressure is higher than towards the poles. This may account for the day fall of pressure, and a reflux as the air cools can be understood, but the writer has always been puzzled by the small wave, which occurs at night, unless radiation can account for it. If so, it should not be so apparent in cloudy weather, but the writer has not stayed up of nights to make sufficient observations to decide this point.

The methods of carrying out a ground survey with an aneroid may now be summed up.

The aneroids procured should have an open scale, extending at least an inch on either side of the pressures anticipated. The temperatures for which the instrument has been graduated, and between which it has been compensated, should be known. Thermometers, including maxima and minima, are necessary, and those for use in the field must have insulated wooden cases. A book of section paper, for plotting the continuous record, must be made up.

The aneroids ought to be calibrated with a mercury barometer at the nearest meteorological station, applying the necessary corrections to the latter, so as to ascertain the index error, or this may be taken from the reduced M.S.L. pressure given in weather reports, which should be obtained regularly. Observation of the wave must be commenced as soon as possible after arrival in the area of operations.

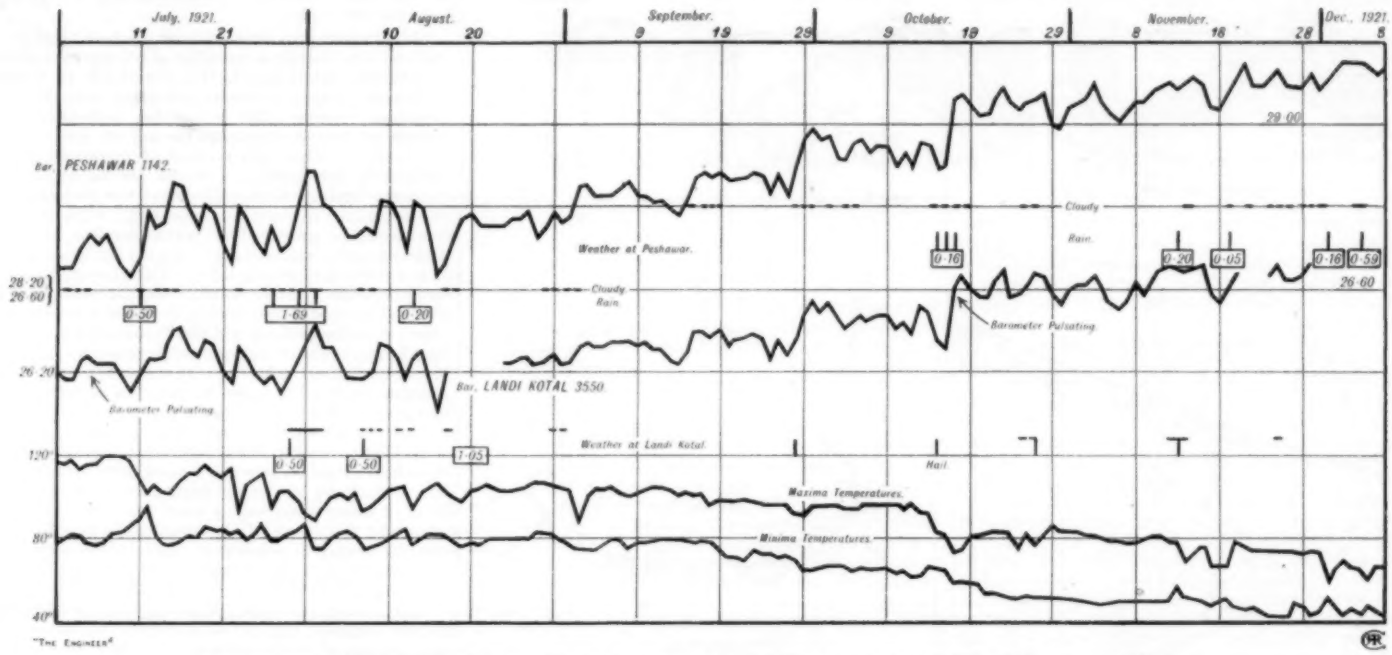
During work in the field, the stations should be selected in as open situations as possible, and readings taken both on arrival and before departure from each station, noting the times of observation and the temperatures at those times. A special halt should be made about the time when the morning fall of pressure commences, and the evening rise of pressure is expected. The closer together the stations are fixed, the less will be the corrections for diurnal wave and abnormal variation, but the time taken in observation will limit the scope of the day's work if stations are too numerous. If possible, the levelling should be "closed" on established benchmarks, or the camp, but "means" do not always improve accuracy.

The field book record should be transferred to another record with columns for :—Station, date, time, pressure, difference of pressure, correction for wave and abnormality, corrected difference, temperatures, mean temperature, corrected mean temperature, height difference, temperature co-efficient, corrected height difference, altitude.

If preferred, the height difference may be obtained by calculation by formula from the recorded temperatures and pressures, but this will involve more calculation. It is quite sufficient for practical purposes to take the average height difference for the corrected pressure difference in the portion of the scale indicated, say, 10·69ft. for a pressure difference of 0·01in. between 26in. and 25in. on the scale, if the U.S. survey scale is used and the instrument is graduated for 50 deg. Fah.

The column for corrected mean temperatures is for use if the lapse rate between the two stations seems to be unreasonable, having regard to the difference of level, and the time elapsed, in which the air may have become further heated.

It may be asked why surveying with an aneroid, which can only obtain approximate results, should be necessary when there are other instruments for obtaining accurate levels. But the employment of these instruments takes time, and time means expense, which can not be afforded in surveying considerable areas. In many parts of the world maps still give comparatively few details or contours. Even where the survey has been thorough, and in the Khyber area it has been thorough, the small scale necessarily involves contouring at considerable vertical intervals, while controlling points have no spot level shown. Surveying with an aneroid will always be a preliminary measure for the elimination of impossible routes, or the decision of the area to be thoroughly surveyed, for railways, water supply or hydro-electric schemes, in rough country. And as such it will be of use to many engineers in the Dominions.



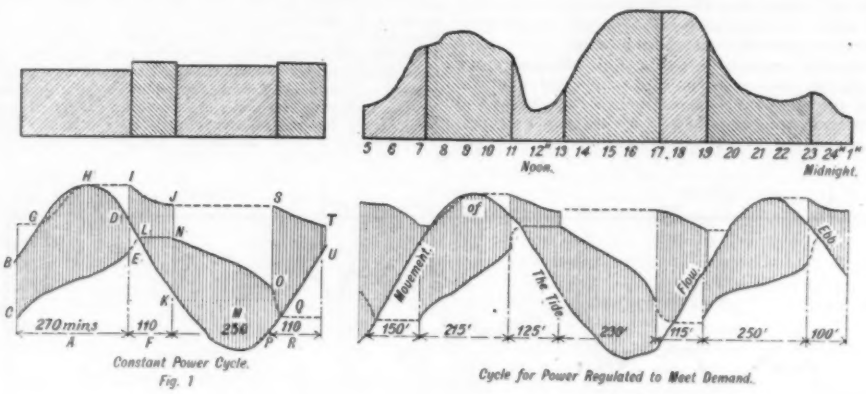
COMPARATIVE VARIATIONS OF BAROMETRIC PRESSURE AND TEMPERATURE AT PESHAWAR AND LANDI KOTAL

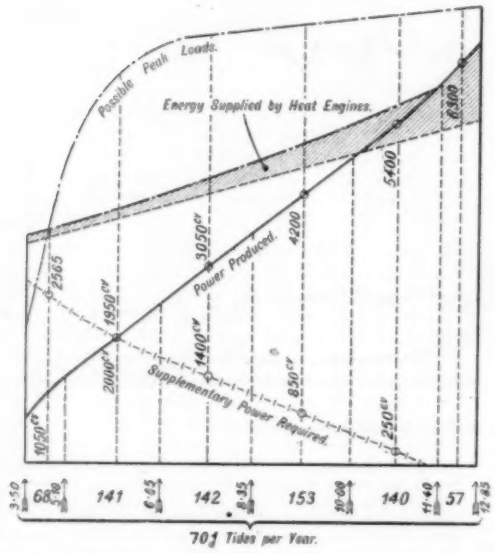
SIXTY YEARS AGO.

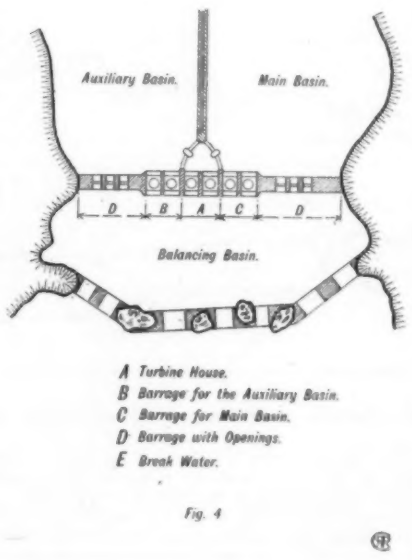
THE Aeronautical Society—now the Royal Aeronautical Society, with which is incorporated the Institution of Aeronautical Engineers—had not been long founded—actually, it had been in existence about two years—when, reviewing its annual report in our issue of March 20th, 1868, we took occasion to express our views regarding aerial navigation and the possibilities of its becoming a practical reality. The Society was supported by many eminent people, including the Duke of Argyle, the Duke of Sutherland, Lord Richard Grosvenor, Lord Dufferin, William Fairbairn, and C. W. Siemens. Under such auspices, we thought, aeronautics ought to flourish, and its problems, which had vexed ingenious men for centuries, ought to be solved. We were not, however, very sanguine of success being attained. Dealing first with the "aerial ship" or navigable balloon, we gave it as our opinion that no successful vessel of that class would ever be constructed unless there were some very remarkable strides in the science of construction. We argued that there was no real analogy between an aerial ship and a sailing frigate or Cunard liner. A balloon of fair dimensions, we calculated, would require screws or paddles driven by engines of at least 140 horse-power to hold it stationary in a wind blowing at 20 miles an hour. That fact, it seemed to us, effectively disposed of the idea of navigating balloons against a current of air, for no balloon could sustain an engine of the required power. The chief, indeed the only, hope of the "aeronautist" lay in the flying machine—a term by which apparently we meant machines of the ornithopter and helicopter classes. We recorded that the members of the Aeronautical Society spent much of their time studying the flight of birds, but we proceeded to show by an argument based on what is now known as "the comparison of similar structures," that a complete understanding of the flight of birds would not enable us by itself to fly. Even although we knew how to make wings and how to use them, we should be as far as ever from flying, for we possessed no means of "putting the wings in motion with a force adequate to the required object." We clearly saw that manual power was quite insufficient for the purpose. As well might the members of the Aeronautical Society try to lift themselves in baskets as to fancy that by their own power they could impart such a velocity to a screw or pair of wings as would raise them into the air. Equally clearly we saw that the first thing to be provided was a machine "capable of exerting vast power without weighing much." Possibly, we said, an engine weighing 20 lb. per horse-power would solve the problem for ever. We would not say that such an engine could not be made, but we confessed that we were at a complete loss to understand of what it was to be made. The modern aero-engine weighs on the average about 1½ lb. per horse-power. There is one British engine, at least, now in existence which actually weighs less than 1 lb. per horse-power.

French Tidal Power Schemes.

THE construction of tidal power stations forms part of a national scheme which is being carried out in France for the utilisation of all available sources of energy with the object of rendering that country as far as possible independent of foreign coal supplies. The problem offers obvious difficulties, largely financial. Experiments upon power generation on a large scale from the tides involve risks which, in the early stages, could only be undertaken with the assistance of the State. When, therefore, the State embarked upon the experimental tidal power scheme at Aber Wrac'h on the coast of Brittany, the problem assumed a new and interesting phase. So far, no practical work has been done in France in the way of drawing energy from the tides beyond the construction of a water wheel in the bay of Saint-Michel with a mole parallel to the shore and forming an inclined chute. Systems which provide for barrages across bays to drive turbines on rising and falling tides, and for scheme. In the Aber Wrac'h installation there is to be one reservoir, and the turbines will be driven on the rising and falling tides. A barrage with auxiliary plant was to have been constructed across the mouth of the river discharging into the bay to provide the energy required when the head of water on the tidal turbines was insufficient. We now learn that this barrage has been abandoned in favour of an auxiliary thermal power station, which will presumably have to produce the full amount of energy for one-sixth of the time, as well as to make up for the periodical falling output and provide for peak loads. The Aber Wrac'h scheme is subjected to a good deal of criticism, and figures have been published implying that the cost will be from four to five times that of a thermal power station producing the same amount of energy; but it should not be overlooked that this is a purely experimental undertaking which may eventually undergo further modifications and even complete changes. The character of the work is one of research, without there being any idea of attaining an immediate economical result. The object is to establish a basis for the technical development of tidal power utilisation, and the fact that orders have been given by the Ministry of Public Works to start upon the construction of the tidal


5 6 7 8 9 10 11 12 Noon 13 14 15 16 17 18 19 20 21 22 23 24 1 Midnight
H I J S T G D L N U B E O C K M Q P R
270 mins 110 256 110
A F P R
Constant Power Cycle.
Fig. 1
of Movement The Tide Flow Ebb
150' 215' 125' 230' 115' 250' 100'
Cycle for Power Regulated to Meet Demand.
Fig. 2





THE DEFOUR TIDAL POWER SCHEME

thermal power stations to complete the intermittent supplies, are regarded as economically impracticable. In such cases the thermal plants have to supply the bulk of the energy, and an auxiliary character is therefore given to the tidal installation, and unless the tidal station can deliver nearly the full amount of energy required to meet variable loads, the cost of construction is far too considerable. In preparing tidal power schemes, the object therefore is to make the auxiliary thermal plant as small and economical as possible, and in all the new tidal power schemes it is sought to make it so far subservient to the main installation that it will only be needed to supply a small proportion of the total amount of energy distributed; at the same time the work put upon the plant must be sufficiently regular for economical running.

One of the reasons for the long delay in proceeding with the Aber Wrac'h scheme was the uncertainty that existed as to how the problem should be dealt with. Financial considerations also retarded the preliminary works, which have consisted in little more than boring for foundations. Practical data are entirely wanting, and the uncertainty is observable in the changes that have taken place in the original power station without further delay implies that the hydraulic services of that department are satisfied with the programme.

An objection against the Aber Wrac'h scheme is that no installation with a single basin can recover energy continuously from the tides in a way that will ensure commercial success. However that may be, there is apparently no reason why the single basin should not be eventually divided to allow of further experiments being carried out with a new system. It is true that the Aber Wrac'h scheme was not based upon a continuous cycle of operations, although such cycles had already been established theoretically with two basins. There was the Bélidor cycle improved by Maire, and then the cycle modified by Monsieur Georges Claude, who proposed to obtain variable supplies of energy with the aid of pumps which would raise the level of one basin at high tide and lower the level of the other at low tide. This would give a continuous and variable supply, although an appreciable proportion of the additional energy would be absorbed by the pumping operations. The system finds detractors who affirm that it is essentially uneconomical. In a practical cycle which aims at producing a constant and variable supply as required, there must be an overlapping of the different phases, and they must be under control. The method of operating the basins and their arrangement should also be devised with a view to reduce as much as possible the necessity of dredging. It is claimed that these results are obtained by the Defour cycle, which appears to have reached a stage when there is a possibility of its being realised practically at a comparatively early date. Two installations are now projected, one at Rotheneuf between Saint-Malo and Dinard, and the other at Le Crotoy in the Somme, under the auspices of an important company, which includes, amongst others, the largest electrical engineering concern in France. At Le Crotoy, where the difference between high and low tides is 10 m., the cost of installation, it is claimed, will be about 30,000,000 f. for a production of 10,000 horse-power. Plans for tidal power installations along the coast of Brittany and the Channel have already been prepared, representing a total of something like 2,000,000 horse-power.

The essential feature of the Defour system is the construction of a dam—Fig. 4—across a narrow part of a bay, and, at right angles to it, another dam extending to the shore, which divides the bay so enclosed into two basins, one having double the area of the other. The smaller reservoir is called the main basin, because it works approximately for about three-fourths of the time, the auxiliary basin, which drives the turbines by a discharge into the sea, being employed to come to assist it. Where the dividing dam joins the main dam it forks out into two branches to each side of the turbine galleries. The fork constitutes the turbine race and has sluice gates putting one or the other basin into communication with the turbines. On each side of the turbine galleries are sluice gates putting the basins directly into communication with the sea. Farther out, the bay is enclosed by a breakwater with oblique openings which divert currents and prevent heavy swells inside. The breakwater consists simply of blocks of concrete and rocks.

The problem that besets the designer of tidal power stations is to supply a quantity of energy corresponding with the varying load. The peak loads are reached in the morning and afternoon when the station is supplying current for industrial purposes. The periods of lowest consumption are at noon and in the evening, when the current is employed almost exclusively for lighting. In the Defour system the auxiliary basin, which only drives the turbines on a discharge into the sea, takes over the work when the head from the principal basin falls too low, and there is thus a fairly regular output during the whole period of the rising and falling tides. This does not provide for peak loads, and the problem would seem to be complicated by the tide advancing one hour in twenty-four hours, thereby making it difficult to ensure a concordance between the energy produced and the load curve. Monsieur Defour solves the problem by varying the relative levels of the two basins. In order to avoid dredging, the auxiliary basin is not emptied to the level of the lowest tides, and the level can be regulated as required. In the same way, the filling of the principal basin may begin when the sea level is sufficiently below the level of the auxiliary basin to provide the head of water required to meet the load. Thus, by adjusting the levels of the two basins in relation to the sea level, it is possible to utilise the energy of one basin at the expense of the other in order to meet the peak loads.

The working of the Defour system is illustrated by the diagram, Fig. 1. It is effected by the opening and closing of sluice gates in the dams on each side of the turbine galleries and of sluice gates between the forked turbine race and the two basins. In the schematic arrangement shown in Fig. 4, six turbines are indicated, whereas there will only be three, one being enclosed by the forked end of the dividing dam and one on each side. During the first phase of 270 minutes the auxiliary basin is filled and the head of water flowing through the turbines into the main basin raises the level of the basin from C to E—Fig 1. The head begins at B C and finishes at D E, when it becomes insufficient. In the second phase, on the falling tide, the sluices are opened into the main basin to raise the level, and the auxiliary basin, which has been filled from G to H, flows through the turbines into the sea, the head beginning at I D and terminating at J K. By this time the main basin has been filled from E to L, and at the beginning of the third phase the tide has fallen to K, thereby producing a head N K. For 250 minutes the main basin discharges through the turbines into the sea, until the head falls to O P. The head is now insufficient, but the main basin continues to fall from O to Q in order to produce more energy later on. In the fourth phase the tide has fallen low enough to permit of the auxiliary basin discharging through the turbines into the sea a second time for 110 minutes, producing heads from S to P and from T to U. By this time the tide has risen to U, corresponding with the level at B at the beginning of the cycle, and the level of the main basin is at Q on a level with C. The cycle therefore begins over again.

The quantity of energy produced is slightly stepped, as shown by the diagram, and this does not conform to the requirements of a variable load, as indicated in Fig. 2, which represents approximately the load curve of a thermal power station. Monsieur Defour obtains this variation by adjusting the levels of the two basins in relation to the tide level. It is obvious that with these three levels, two of which can be

controlled, the heads on the turbines or the volume delivered, can be varied within fairly wide limits, and they may be so arranged as to coincide with the varying load. The work estimated to be done by the turbines at the proposed tidal power station at Rotheneuf is plotted in Fig. 3. This gives the average for 701 tides. The thick line indicates the average power produced, the broken line the supplementary energy required from the auxiliary thermal power station, and the dotted line the possible peak loads that can be obtained with the turbines. The shaded part shows the proportion of energy supplied by the thermal plant to the whole required to complete the loads.

The working of a Defour tidal power station depends upon what appears to be a complicated manipulation of sluice gates, which have to be opened and closed at various times in relation to each group of sluices, but it is declared that the operation is simple and automatic. The mechanical arrangement consists in floats on each side of the gates which act through differential pulleys and bell cranks and switch on the electric motor as soon as they are in pre-determined positions relatively to each other. Those positions can be adjusted by a displacement of the differential pulleys. There are other ways of opening and closing the gates, and whichever is finally adopted it appears that the gates can been manipulated by one man who sets the gears according to the difference between the sea and basin levels at which the gates are to be opened and closed.

In the opinion of the Aber Wrac'h engineers, the necessity of employing suitable turbines is of great importance. Special turbines have been designed to be made of material that will resist sea corrosion. Monsieur Defour affirms that in his system special turbines are not required, since they are always working, and, being continually in movement, they cannot corrode. He provides two variations of heads of water, from 1·5 m. to 4·5 m. and from 3 m. to 9 m., and he therefore proposes to employ ordinary turbines with one change of speed. As these two ranges of speed overlap to the extent of 1·5 m., there is ample time for changing the speed.

This account of what is being done in France shows that the problem of drawing energy from the tides is being worked out on a rational basis. So far as theoretical considerations go, the schemes are proving attractive to big electrical and mechanical engineering corporations, which see in this new branch of experiment a considerable opening for industrial activity. It seems highly probable that, in addition to the Aber Wrac'h experiment, something will be attempted at a comparatively early date. As practical experience is entirely lacking, it cannot be averred that the most promising scheme can be realised without encountering unsuspected difficulties, but the possibilities are so great that a beginning will certainly be made, and the enterprise of the French State and of French engineers merits that their efforts should meet with success.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

OIL ENGINE PERFORMANCE ON COAL OIL.

SIR,—The paper contributed by Mr. J. S. Brown in the *Journal* of the Royal Technical College of Glasgow last December regarding the possibility of using oils from coal as Diesel oils is of great interest, and it is a question to which I personally have given a great deal of attention.

The summary of the above paper, which appears in THE ENGINEER of March 9th, although comprehensive, does not give all the necessary data enabling one to draw the correct conclusions. The chemical and physical characteristics of the various oils on which Mr. Brown did his work are not given as completely as might be desired, and it is evident that the oils used for comparison in the test carried out by Mr. Brown are not, all of them, oils obtained from bituminous coal. For instance, the oil referred to as Turner oil is, in all probability, from a cannel coal, the oil from which, as is common knowledge, is quite different from ordinary coal oil, not only as far as specific gravity is concerned, but also chemically.

It can be said that all oils from coal will, when mixed with natural well oils, give an asphaltic sludge deposit. If the oil has been subjected to secondary decomposition the sludge sediment becomes much heavier. On the other hand, oils from cannel coal may not give a sludge deposit on mixing with well oils.

Since Mr. Brown expressly mentions that the oils he used were coal oils obtained by low-temperature distillation or carbonisation of coal, confusion would have been avoided if he had communicated with the people he obtained the oil from before publishing his test and found out definitely whether the oils were produced from cannels or from ordinary bituminous coals, and had not left this important question to the discretion of the readers, who may or may not know the difference.

The oil properties given by Mr. Brown in his Table I. show a flash-point of the Turner oil of only 58 deg. Fah. This is, of course, below the generally permitted Diesel oil flash-point, which for land and general marine work should not be below 150 deg. Fah., and for naval use not below 170 deg. Fah. It is therefore easily understood why the Turner oil would ignite under no-load conditions.

The story of this particular test on the "L. & N." oil is rather interesting, since it was the outcome of a discussion between the head of a famous firm of Diesel engine builders, a well-known consulting engineer, and myself. During the discussion the question was raised as to whether an oil with a hydrogen percentage of less than 11 per cent. could be used as a Diesel oil. The Diesel people maintained that such oil would be of no use, since it would not ignite. It was, therefore, decided to have a private test conducted on an oil which would be, according to present knowledge, unsuitable for the purpose.

If this oil would fire, then the chances were that an oil containing a large percentage of acid bodies, such as are commonly known as tar acids, would not present difficulties. It was to support my contention that an oil with a relatively low hydrogen percentage and containing a large percentage of tar acids would be suitable, that the test was carried out. The oil which was sent to the Royal Technical College, Glasgow, was tested in our laboratory, and had the characteristics given in Column 1. Column 2 gives the characteristics of a Diesel oil, also made from coal, but of a much lighter character, and approaching the well oil much more closely. The oil, according to Column 2, will fire and behave just exactly as an ordinary petroleum Diesel oil with the same flash-point. Column 3 gives, for comparison, a standard natural Diesel oil.

Comparisons Between "L. & N." Coal Oils for Diesel Use and Ordinary Diesel Oil.

	1 "L. & N." oil heavy oil.	2 "L. & N." oil light Diesel	3 Diesel oil from well oil.
Boiling range, °C.	225–410	210–310	200–400
Per cent. tar acids	40	None	None
Carbon residue, per cent. ..	0·8	0·1	0·5–0·9
Ash, per cent.	Too low to determine	None	Max. 0·05
Specific gravity at 60° F. ..	0·992	0·931	0·86–0·910
Open flash-point, °F.	205	205	170–200
Closed flash-point, °F. ..	190	—	150–190
Fire point, °F.	230	245	220–230
Carbon, per cent.	84·71	88·0	83–84
Hydrogen, per cent.	8·94	10·5	11·5–13
Sulphur, per cent.	0·45	0·4	2·5–3
Oxygen plus nitrogen, per cent.	5·5	1·0 or less	
Viscosity, 70° F., Rw. Sec...	360	35	200–500
Gross cal. value, B.Th.U. per lb.	17,600	18,400	18,500–19,000
Nature of oil	Pitch free crude	Neutral	Topped oil

Suitable Diesel oils have formed a bone of contention between producers and users, not only in this country, but more so abroad, and I was informed that during the war the German Admiralty, being in desperate need of Diesel oil for their submarines, sent their Diesel oil specification to various oil firms—who produced oil from coal—specifying that the Diesel oils were not to contain more than 3 per cent. of tar acids. Diesel oils within this specification were forthcoming, and the results were good. Then some wag sent a sample of the tar acids which had been removed from the coal oil and mixed with 20 or 30 per cent. of neutral oil to the German Admiralty without saying anything about the composition of the oil, and received a very excellent report upon it. The oil contained about 70 per cent. tar acids, and was, with the exception of flash-point, about as far removed from natural Diesel oil as is conceivable. It will thus be clear that ideas of suitable Diesel oils are still rather hazy, and tests are of maximum value only when all possible chemical and physical data are appended, as this is the only way in which it is possible to form the judgment in comparison with a practical test carried out.

On a subject which is going to be of vital importance to this country, Mr. Brown's test would have been still more valuable if he had given some few more reasons for the conclusions he had drawn, however favourable they might have been to oils produced from coal, and had differentiated duly between oils produced from bituminous coals and oils produced from cannel coal.

In fairness to all it is dangerous to compare data obtained under similar conditions from oils of such varying characteristics as indicated by the distillation curves.

HARALD NIELSEN.

March 19th.

SIR,—In your issue of March 9th the results of tests on three low-temperature oils in a Diesel engine are given and compared with the results with shale and coke oven oils. The matter is of considerable national importance in view of difficulty arising at any time in obtaining ample supplies of petroleum oils. It is satisfactory to note that two of the low-temperature oils tested gave promising results. On the other hand, the oil from the Maclaurin process failed to give records owing to the difficulty of pumping such a thick oil.

In considering these tests it ought to be borne in mind that the oils are not all in the same category. The shale oil, the creosote oil and the L. and N. oil are each distilled products, whereas the Turner oil and the Maclaurin oil are taken direct from the tar well. The Turner oil tested, however, is representative only of the lighter fraction of the oil obtained in the distillation of coal by the Turner process. The Maclaurin oil is the crude oil obtained from the coal without any separation beyond settling.

It is evident that oils more suited for use in Diesel engines could be obtained by distilling such crude oils, but distillation of crudes leads to the production of large quantities of pitch. A marked disability of crude low-temperature oils is the resinous deposit thrown down on mixing such oils with petroleum oils, and this objection will certainly limit their market and lower their price for Diesel engine use. It is the presence of these resinous products, moreover, which lowers the calorific value of low-temperature oils, and therefore further reduces their monetary value.

In 1916 I showed that the bulk of the resinous products contained in low-temperature oils could be thrown down by agitating with a light petroleum oil and acidulated water. If the oil used were a gas oil of about 860 sp. gr. the whole of the oil remaining would be suitable for Diesel oil use. In this way two gallons of Diesel oil could be got by the use of one gallon of gas oil.

By using a lighter petroleum spirit and distilling it off the same petroleum oil can be used for precipitating the resins in several batches of low-temperature oils. In this case the distillation could be stopped so as to leave sufficient light petroleum in the mixed oils to give the fluidity desired for Diesel engine purposes.

The effect of precipitating the resins from a Maclaurin oil would be evidenced in a reduction of the specific gravity and viscosity, in a lowering of the flash point, in an increase in the C.V., and in a reduction in the sulphur ash and water content, as well as in absence of sludging. The oil resulting would still retain a percentage of liquid phenols, which could be extracted before distillation if the market warranted. The commercial result of this treatment would depend upon the prices obtainable for the Diesel oils and the resinous products separated.

On distillation these resinous products give phenolic distillates, and it would appear to me to be more economical to export these highly concentrated phenolic oils for timber preserving purposes than oils with a relatively small percentage of phenols. Creosote oil consists largely of neutral oils containing phenols, bases, and naphthalene.

The United States has a sufficient supply of neutral hydrocarbon oils of its own without importing neutral oils from this country. On the other hand, this country will not require to import as much petroleum oil if the neutral portion of the low-temperature oils can, by mixing, be rendered more suitable for Diesel engine purposes.

March 20th. R. MACLAURIN.

AUTOMATIC SUB-STATIONS.

SIR,—I have read with interest the leading article in your issue of the 9th instant, in which reference is made to a paper of mine before the Institution of Electrical Engineers. Your article conveys the impression that I favour the use of two 750-volt machines in series on 1500-volt systems, and needs qualification. This is certainly not my view in the case of a 25-cycle system, but on a 50-cycle system most machine designers at present seem to regard the single machine as being on the border line of safety, more particularly if it is not considered good practice to place entire reliance upon the high-speed breaker. Single 1500-volt, 50-cycle machines are, however, being built at the present time, and their performance will be watched with interest. It is to be hoped that it will shortly be possible to make the single machine standard practice, but in order to attain this end every possible expedient which seems likely to improve the behaviour of the machines should be tried. I am, personally, of the opinion that the vertical design of rotary converter would allow a freer dissipation of the vapours formed during flashing than any existing design, and would therefore tend to operate better under short-circuit conditions. This design may therefore be found to be the last improvement necessary to make the single 1500-volt, 50-cycle rotary a practical success. Apart from this and some slight saving in floor space, I doubt if the alteration in design would justify the development costs entailed by any manufacturer who proposed to adopt it in place of his present design.

I entirely endorse your view of the desirability of reducing the complication of the automatic sub-station, and progress is tending in that direction wherever it is possible without sacrificing reliability. I also agree that the use of rectifiers in place of rotary converters would result in some simplification, although not as much as might be thought at first sight. *Inter alia*, the rectifier's vacuum pump and insulated cooling water supply must not be overlooked. Unfortunately, however, when taking into account both first cost and reliability, rectifier proposals have not, up to the present, shown any marked superiority for heavy traction work, but rather the reverse.

British engineers are fully aware of the advantages and disadvantages of the rectifier for heavy traction work, and will adopt it as soon as its development has reached the stage where the former clearly outweigh the latter, if, when that time comes, they still find direct current to be preferable to alternating current for operating the trains.

H. B. POYNDER.

Newcastle-upon-Tyne, March 20th.

SIR,—We have been very interested in reading the leading article in your issue for March 9th on the above subject. The position you have taken up with regard to automatically operated rotary converter sub-stations, we feel, is the right one, because without question they are most complicated and the maintenance charges in connection with them are very heavy.

The automatically operated rectifier is an extremely simple proposition, and with the class of gear we utilise for the automatic features is very simple as regards the wiring. The main portions of our automatic features are incorporated in a special form of rotary switch which is

THE WORK METER—ELECTRICAL CONTACT MAKER

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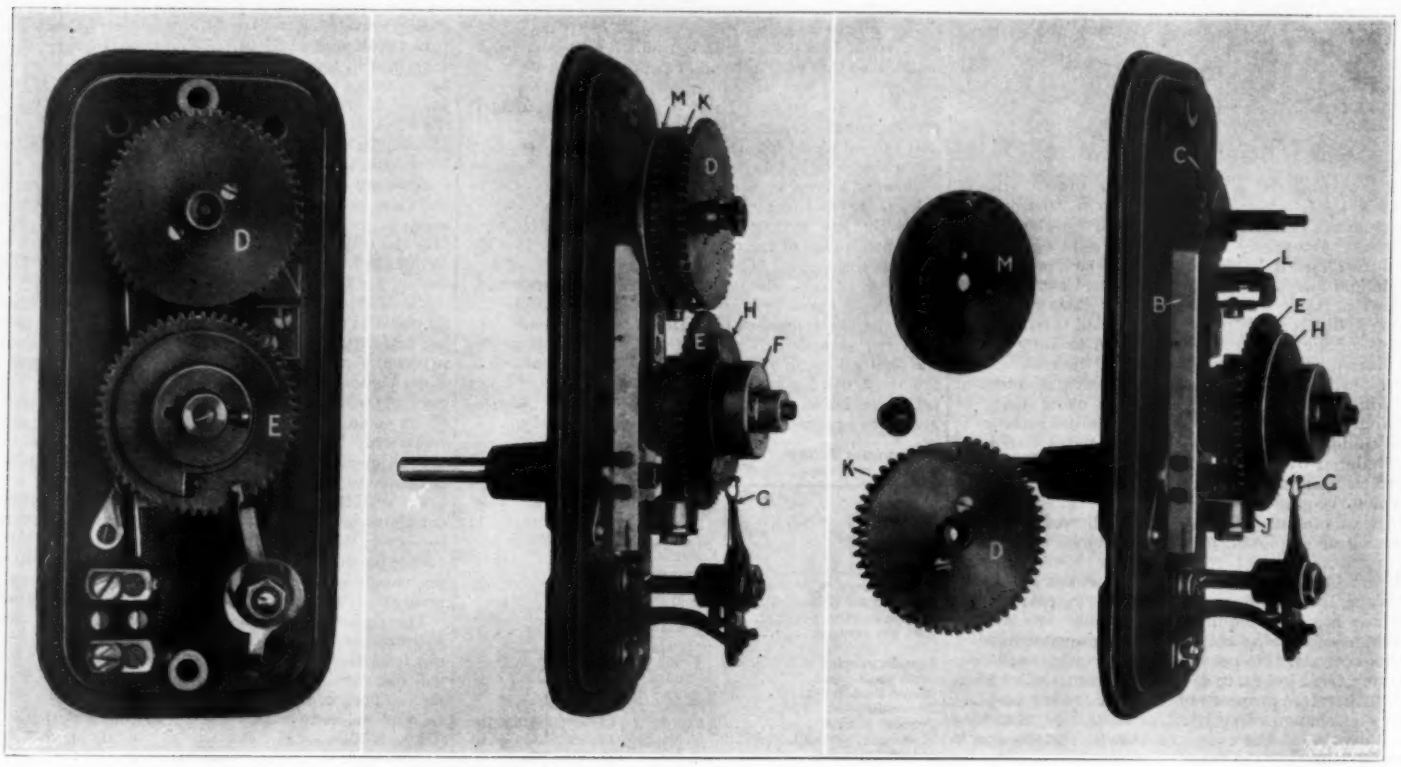


used extensively on the Continent for other purposes as well, and in consequence of the use of this switch the appearance of our switchboards at the rear shows no complication whatever because the gear is an absolute minimum.

Reading your notes you give the impression that the rectifier is still somewhat expensive, whereas this is far from being the case. The number manufactured has so increased and the method of manufacture has been so simplified that prices have decreased very considerably during the last year or two. The position is such to-day that our prices in this country are, generally speaking, no higher than those of rotary converters, and frequently less.

You might be interested to know that for traction service, both suburban and main line, there are distinct indications that on the Continent at any rate the rectifier is preferred to the rotary converter. Most of them are automatically operated

British Brown-Boveri, Ltd.
(Sales Division).
R. L. Morrison.

London, S.W. 1, March 20th.

COMPENSATED SPRING GEAR ON LOCOMOTIVES.

Sir,—In the interesting letter from Mr. Dewhurst, which you publish in your issue of the 16th inst., there is one paragraph which, although not written with that intention, forms a remarkable commentary on the Sevenoaks accident. I quote the paragraph in full :—

"The writer, apart from continuous observation and proof of this fact—*i.e.*, of the indispensability of compensated springing on severe roads—in every-day working, made tests with locomotives in such circumstances, and actually had practical demonstration of how a soft place, or a lack of super-elevation in a section of the outer rail of a curve, will produce a derailment of an uncompensated locomotive when the extreme wheel of a rigid wheel base encounters the low place, whilst a similar engine with compensating levers will not derail. The reason for this being, of course, that with the uncompensated gear the wheel passing over the low place loses some of its imposed weight, whilst with compensating beams the calculated weight distribution is very closely maintained."

In the Board of Trade report on the accident it was mentioned that compensated springing might be tried on future engines of the "River" class, and I would add that Great Western engines with a leading two-wheeled bogie have the bogie springs compensated with those of the leading driving wheels by a connecting beam.

Forest Gate, E. 7, March 17th. C. M. Swatman.

GERMAN MACHINE TOOLS.

Sir,—Some while ago you were good enough to publish a letter of mine, dealing with the decision of the Machine Tool Trades Association to exclude German machine tools at the forthcoming Olympia Exhibition, whilst admitting those of American and Swiss manufacture.

At that time I dealt with the moral side—the unnecessary insult to German manufacturers. I wish this time to raise the question of the extreme folly of the policy.

It was, I think, urged at the time by some of your readers that the result would be a very great increase in the number of English visitors to the Machine Tool Exhibition at Leipzig. This forecast was entirely correct, and we have had the experience of large numbers of English users of machine tools visiting Leipzig and getting an erronious impression of German machine tool design which arises through a massed exhibition of their products.

We think that their enthusiasm would have been considerably more moderate if they had had the opportunity of seeing these machines at the same time as those of English manufacture. They would then have realised that those English manufacturers who have specialised and manufacture under modern conditions have but little to fear from German competition.

It must further be realised that the industry in Germany is much larger than in England, and therefore there are many types of machine tools on which they can specialise and which are ahead of those of English design. These compare and compete almost exclusively with those of American manufacture.

Incidentally, it is interesting to know that there is a very considerable import of American machines into Germany and German machines into America.

The Selson Engineering Co., Ltd.,
H. M. Selson, Managing Director.

London, E.C. 1, March 20th.

THE HEAVY-OIL ENGINE AND ELECTRICITY SUPPLY.

Sir,—In a leading article in The Engineer of March 2nd, it is stated, on page 242, that a firm of consulting engineers had submitted plans for a 21,000 kW oil-engined peak load station, and it was not found possible to put forward British-built engines, as our oil-engine makers could not offer such large units when tenders were called for. I sincerely hope this is not correct.

I am sure that among many British oil-engine builders the following manufacturers could produce the plant required :—Harland and Wolff, Ltd., four-cycle double-acting engines up to 10,000 B.H.P. and beyond ; William Doxford and Sons, Ltd., two-cycle opposed piston type engines up to 10,000 H.P. ; John Brown and Co., Ltd., and the Fairfield Shipbuilding and Engineering Company, Ltd., two-cycle single-acting engines up to 10,000 B.H.P. ; Vickers-Armstrong, Ltd., double-acting two-cycle engines up to 11,700 B.H.P.

Besides the above-mentioned firms, J. G. Kincaid and Co., Ltd., of Greenock, has just recently turned out its first 5900 B.H.P. double-acting four-stroke engine, with eight cylinders ; while the North-Eastern Marine Engineering Company, Ltd., of Wallsend, has also built a four-cycle double-acting engine quite recently.

H. W. Watts,
Resident Electrical Engineer.

Epsom, Surrey, March 20th.

The demand for electricity in Sydney, New South Wales, is increasing at the rate of 15 per cent. per annum.

The Work Meter.

The device we are about to describe, a device known as the "work meter," is a means of giving effect to a very simple principle. It is desired to measure the working of machinery—a lathe, a loom, a dye vat, a motor vehicle, a rubber vulcaniser, a marine engine—to obtain a record of the speed at which it is run, when it is stopped and started and the length of the periods during which it is active or idle. The principle employed for this purpose in the work meter consists of using an electrical contact maker which is fitted to some part of the machine, and which at the end of every so many revolutions of the machine sends an impulse to a distant recorder consisting essentially of a strip of paper moving beneath a stylus at a uniform rate under the control of a clock.

Before passing on to describe the work meter in detail and to discuss certain typical applications of it, we deem it desirable to deal with an aspect of the invention with which many, when they are first introduced to it, will no doubt be strongly impressed. In the light of a cursory knowledge of what the device is intended to do, one might stigmatise it as a mechanical policeman or as an instrument designed for the purpose of still further binding the man to the machine. It is easy to excite prejudice against any apparatus or system which seems to have for its main purpose the tightening of managerial control, and the extension of the management's ability to observe and record the efficiency with which workshop processes are conducted. A further understanding of the facts will, however, show that in the hands of a management which is not wholly unscrupulous the work meter is not a means of scientific coercion, and that it is an appliance which, given co-operation and mutual trust, can be made to yield important benefits, both to the employer and the employed. The incidence of idle periods in the operation of machinery is not invariably, or even mostly, caused by deliberate idleness on the part of the worker. Quite commonly, stoppages or under-production are caused by defective organisation, such as, for example, a temporary or permanent bottle-neck in the flow of material through the departments. Again, there are numerous processes which depend for their success upon the worker taking certain action at precise moments, such as changing the speed of his machine or adding ingredients to his furnace or bath. If the management has a means of assuring itself that proper attention is being paid by the worker at these critical moments, it is in a position to prescribe with safety periods during which pauses for rest may be taken. Again, there are operations, such as those performed by the railway signalman, which have to be logged and of which the log, in the event of an accident or dispute, will be of prime importance, provided it is complete and unassailable. To these and other conditions the work meter can be applied without the least suggestion of tyranny.

The principle of the work meter, although simple, has called forth a considerable amount of constructional ingenuity in its practical development. The contact maker may be considered first. The design of this portion of the equipment reflects three main requirements. In the first place, the arrangement has to be such that when the machine under control is stopped, the contact maker will at no time stop with the contact made. Were such an event to occur, the recording stylus in the manager's office or wherever the recorder is placed, would be held depressed, and would make a continuous mark on the paper. In actual fact, the paper would be torn, for, as will be explained later, the recorder makes use not of a

pen or pencil, but of a needle, which perforates the paper each time an impulse is received. In the second place, the contact has to be established not momentarily, but for a short, definite, perferably constant period, in order to allow the magnet operating the stylus time to build up its field to full strength. A momentary contact, such as might easily be arranged to be given by a simple "flick" type of contact maker would, unless the operating current were of a high voltage, fail to operate the stylus or be uncertain in its action, by reason of the magnetic lag arising from the self-induction of the magnet coils. In the third place, manufacturing considerations require that the contact maker should be a standard product applicable with the least possible amount of change to different machines. The principal difference encountered is one of speed. In order to adapt the contact maker to give an impulse once a minute, or at any other standard interval, whether the speed of the machine be high or low, facilities have to be provided for changing the gear ratio in the contact maker

The contact maker is illustrated on page 328. The shaft A is driven direct by the machine under control. It projects through to the front of the base and at its end is formed with a small crank, which engages with a block fixed to a pawl B. This pawl operates in conjunction with a twenty-five-tooth ratchet pinion C. This 25-to-1 speed reduction is standard, and is followed by a variable reduction, which is chosen at such a value as will result in the wheel D being driven at one revolution per minute or at some other standard rate. This wheel D is toothed for about three-quarters of its circumference. Accordingly, for 45 seconds or so in every minute it is in mesh with the wheel E, and rotates that wheel against the action of a fly-back spring inside the casing F. For the remaining 15 seconds D loses its engagement with E. Immediately the engagement is lost E flies back against a stop. During the winding-up stage, two electrical contacts G, separated

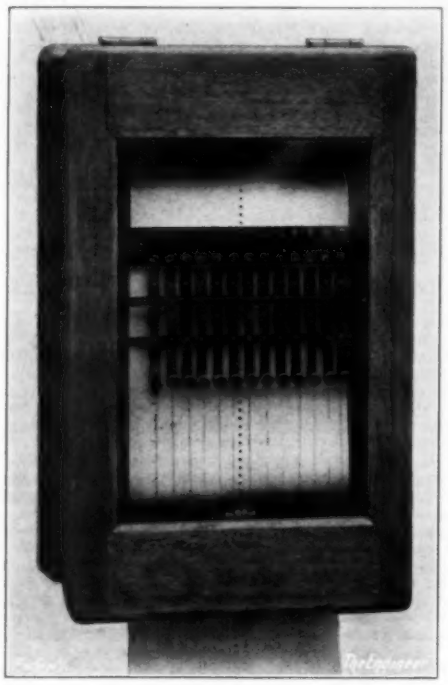


FIG. 1—MULTIPLE UNIT RECORDER

from each other by a strip of insulating material, are lifted on to the top face of a disc H rotating with the wheel E. During the fly-back period the disc rubs between the contacts and completes the electric circuit. The disc is cut away for a portion of its circumference, and the radial edges of the cut-away part are ramped in opposite directions to secure the desired action of the contact fingers. When the wheel E is against its stop, the contact fingers are in the cut-away portion of the disc, and are not in electrical connection with each other. Electrical connection between the contacts is made only during the actual fly-back movement of the disc and as that movement, when once begun, is self-completing, the stopping of the machine at any point cannot result in the electrical contact being indefinitely maintained.

The period occupied by the fly-back motion is determined by various factors, including the friction of the bearings of the wheel E and the strength and setting of the fly-back spring. In order to eliminate the effect of these variable factors and to obtain a constant fly-back period, a small centrifugal governor J is driven off the boss of the wheel E. The balls of this governor are carried on spring arms, and when they fly outwards they press against the inside of a circular cage surrounding them, and are so caused to exert the required governing resistance.

With the exception of the variable gear reduction between the ratchet wheel C and the wheel D all the parts we have described are standardised. The variable gearing is simple and interesting. Its feature is that the variation is obtained without varying the centres of the wheels and pinions composing it, a feature of importance from the point of view of standardised manufacture. Behind the wheel D there is attached a standardised forty-eight-tooth wheel K, which is completely toothed round its circumference, and which is in constant mesh with a standardised six-tooth pinion L. Behind the wheel K there is another wheel M which engages with a pin on the face of the ratchet wheel C, and therefore rotates with that wheel. Driving connection between the wheel M and the wheel K is established by way of the pinion L. If the wheel M were an ordinary toothed wheel, the pinion L would be an "idler," and the gear ratio would be exactly the same as that obtained by the direct engagement of the wheels K M with one another. The wheel M is not, however, an ordinary toothed wheel. The number of teeth on it is varied to suit the speed reduction required, but in all cases its diameter is constant, namely, at the diameter determined by the centres distance of the ratchet wheel C and the pinion L. In our engraving the wheel M is shown with but one tooth—or rather with one tooth gap—the rest of the periphery being plain. Each time the tooth on the wheel M comes round, the pinion L is moved forward one pitch distance, while during the remaining portion of the revolution of the wheel M the pinion remains stationary. With one tooth on the wheel M, therefore, the gear ratio between the shaft A and the disc H is $25 \times 6 \times 8$ or 1200 to 1. By varying the number of teeth on the wheel M without varying its diameter, the

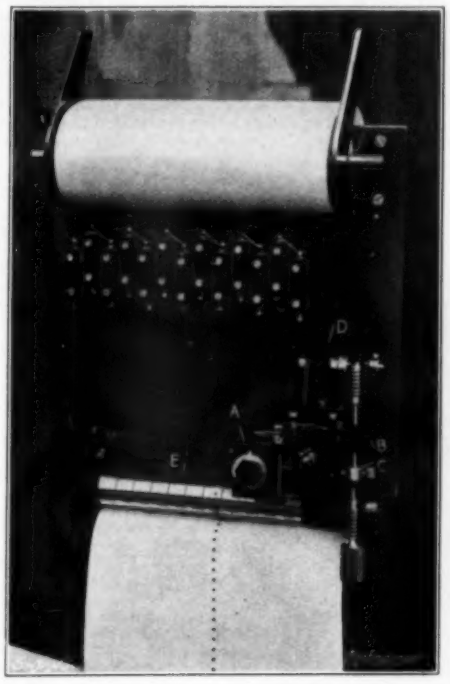


FIG. 2—REAR VIEW OF RECORDER

makers can adapt the device to give any desired speed reduction.

It will be appreciated that if the wheel M consisted of a plain disc with a single tooth projecting from it, and if the plain portion of its circumference were cut down to or below the root diameter of the projecting tooth, the pinion L would be out of driving contact with the wheel M, except once during each turn of that wheel. As a consequence, the disc H would not experience the desired "building-up" movement, but would merely move forward through one-forty-eighth of a turn per revolution of the ratchet wheel, and then slip back under the action of the spring in the casing F. The pinion L has to be locked against backwards rotation. A "click" applied to the wheel K might be used for this purpose, but in practice the makers adopt quite a different method of securing the same end.

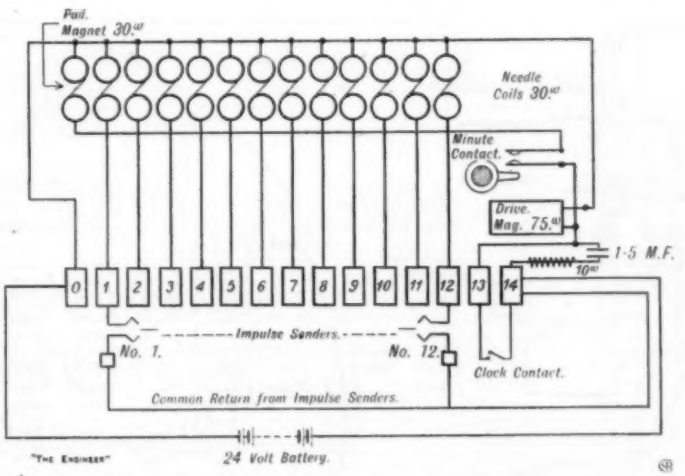


FIG. 3—ELECTRICAL CONNECTIONS OF WORK METER

The wheel M is of diameter equal to the diameter over the tips of the teeth or tooth formed on it, and the teeth are formed, not as projections, but as gaps. Each tooth gap is formed in a portion of the periphery which is pressed to stand out from the general plane of the wheel. The displacement suffered by these small portions during the pressing is in amount equal to the thickness of the disc from which the wheel is formed. The plain portions of the wheel are therefore in one plane, while the gaps are formed in metal displaced into the immediately contiguous plane.

It is obvious that such a wheel will not engage with an ordinary pinion for the plain portions of the wheel periphery would foul the pinion teeth. In practice, every second tooth on the pinion is cut down to the root diameter in line with the plain portion of the wheel. During the non-driving portion of the movement the plain portion of the wheel moves through one of these gaps in the pinion teeth. The preceding tooth of the pinion is continuous and resting against the edge of the plain portion of the wheel locks the pinion against backwards rotation during the non-driving period. It will be understood that the motion of the pinion L and of all the parts which follow it is discontinuous, and that the wheel M is the only item that has to be changed to adapt the contact maker to a machine of any speed.

The second element of the apparatus is a clock with a simple electrical contact in the escapement. This contact is closed once during each swing of the pendulum; that is to say, once every one to two seconds, according to the type of clock. Its effect on the clock is to make it gain slightly, but after it has been fitted the pendulum is re-regulated to restore the correct rate.

The third element is the recorder to which the electrical impulses are transmitted from the contact maker and the clock. In Fig. 1 a recorder arranged for connecting to twelve separate contact makers is shown. The electrical impulses from each contact maker operate a separate electro-magnet, which, when energised, pulls down one of the twelve arms shown in the engraving, and causes a needle at the end of the arm to prick the paper travelling beneath it. The rate of movement of the paper is about $3\frac{1}{4}$in. per hour, or something less than $\frac{1}{16}$in. per minute. It is so slow relatively to the speed with which the needle punctures the paper that the needles prick and do not tear the paper. The recorder can be charged with a roll of paper 67 yards long, which is sufficient to last for thirty-one days' continuous operation. As neither pencil nor ink is employed to make the record, the changing of the paper once a month is the only item of maintenance to which attention has to be paid.

The thirteenth arm, on the left-hand side, is the time marker. When it descends once a minute it presses the paper against a wheel beneath it, which makes one revolution per hour. This wheel is formed round its periphery with a sequence of points which when the die on the end of the arm descends are caused to emboss the paper. The time record left by the wheel on the paper consists of one embossed dot at the minutes, two dots at the five minutes, three dots at the quarter and three-quarters hour, four dots at the half hour and five dots at the hour. The hour is not named on the record automatically, but at the start of a run the time-embossing wheel can be set by hand to ensure that it shall make a five-dot impression exactly at the hours, as indicated by the clock.

The impulses from the clock are taken to an electro-magnet A, Fig. 2, which is caused to operate a pawl engaging with a ratchet wheel B, which is so chosen relatively to the period of the clock that its shaft shall make one revolution per minute. A cam C on the ratchet wheel shaft makes an electrical contact once a minute and transmits an impulse to the arm of the time-marking wheel. That wheel is shown at D. It is caused to make one revolution per hour by means of a 60-to-1 worm reduction on the ratchet wheel shaft. A similar worm reduction at the other end of the shaft rotates the paper-driving roller E at one revolution per hour. A diagram of the electrical connections is given in Fig. 3.

A graduated celluloid scale is provided whereby the length of a period during which any one of the machines under control fails to register on the chart or registers at a reduced or an excessive rate, can be read off by applying the scale to the appropriate line of prickings.

The work meter in the form in which it is illustrated herewith is applicable in a large number of industries, wherever, in fact, the machinery employed involves at any point a rotating shaft, a reciprocating member or other part executing regular movement. In weaving sheds it can be used to record the performance of any loom, and will show the number of yards of material produced by it in any given period, besides showing instantly when a stoppage occurs. In spinning mills it has already proved its usefulness by revealing the expenditure of very irregular and quite unnecessarily long times on the process of "doffing." As a result of its application, doffing times have been standardised, with, as a consequence, the saving, so we are informed, of large sums annually. In the dyeing industry the device, we learn, has given particularly good results, and its use has led to a great increase in production, especially under piece-work conditions. It has also reduced the heavy loss incurred by the failure of the dyers to adhere to the required time-table, which is a feature of certain of the operations for which they are responsible. In the printing industry the device can be used to analyse the time spent in "making ready" or otherwise lost, and so to permit the cause of some of the delays to be eliminated. In the paper making industry it is claimed to have a big field of application in recording any changes of speed likely to affect the quality or thickness of the paper produced. In power-houses, steel mills, and general engineering works, and in connection with colliery and other machinery for handling materials, the device has many obvious uses.

Special applications of the work meter are being developed, in addition to the standard form which we have described. One such application now engaging attention is its use on board ships for logging automatically such items as the speed of the engines, the orders from the bridge to the engine-room, the helm angle, and so forth. In connection with railways, it is being studied with a view to logging the movements of signal levers, and, when placed on the train itself, to recording the speed, the time taken from station to station and other particulars. A special design of machine producing one or at most two

records, and embodying within it its own clock movement, is now being developed for use on mechanical road vehicles. This machine will give a continuous record of the speed of the vehicle, the duration of stops, whether the engine is left running or not, and of other data that will enable a complete analysis of the performance of the vehicle to be made. Other applications are in view in which the plant to be dealt with will not comprise a continuously rotating shaft, but will embody parts, such, for example, as the door of a furnace, which are operated by single movements at considerable intervals.

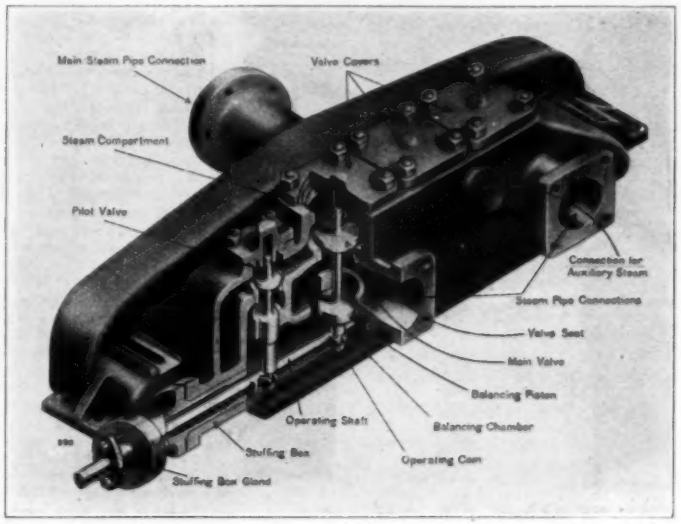
The device is being distributed for Work Meters, Ltd., by Lewenz and Wilkinson, Ltd., 25, Victoria-street, Westminster, S.W. 1.

A New Regulator for Locomotives.

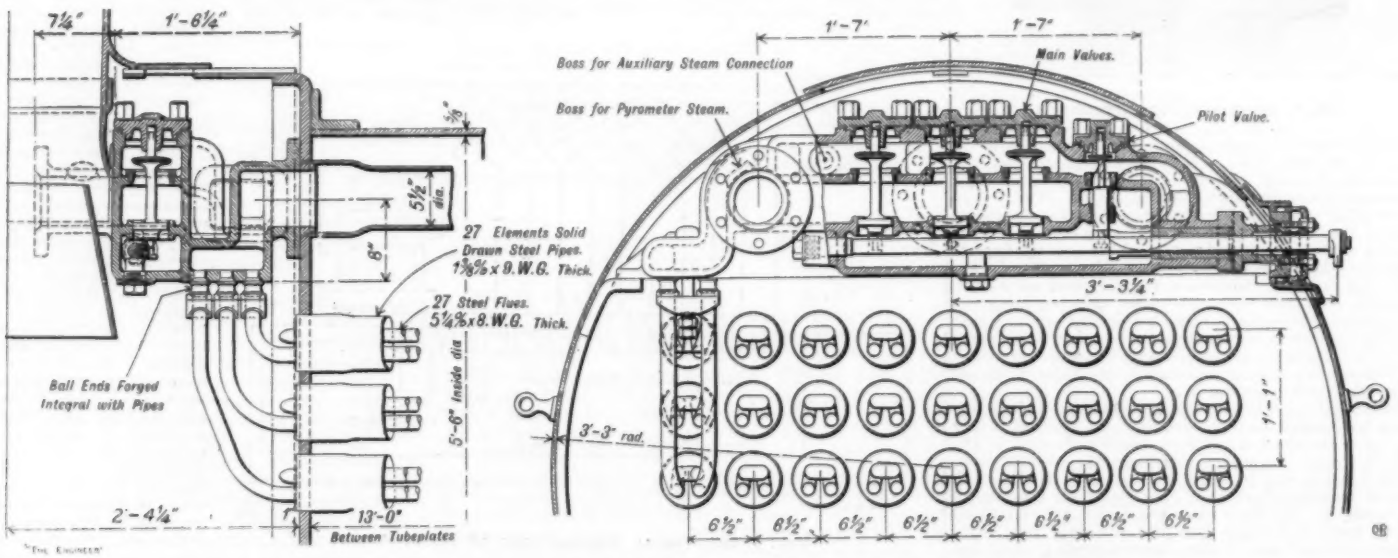
EVER since the locomotive settled down into a consistent form the regulator has been placed in the dome, where it can be carried well above the water-line. But as locomotives get bigger the dome gets smaller, and the advantages of that position become less. Furthermore, superheating has made a difference. In the normal arrangement the steam passes through the regulator valve, which may be a good way back on the boiler, enters the steam pipe and travels forward to the superheater header. Two facts follow from this arrangement. In the first place a long and large steam pipe, and the superheater header and elements have to be filled before any steam can reach the cylinders, and in the second place since the superheater is empty when the regulator is closed, thereby producing a possibility of burning the elements, provision has to be made for drawing air or steam through it or a vacuum valve must be set on the top of the header to prevent a vacuum being formed in the superheater when the engine is coasting.

For a long time engineers have recognised the disadvantages of the present arrangement, and have sought means of placing the regulator between the superheater and the cylinders. It is, however, only recently that a practical solution has been found. It is known as the "M.L.S." Combination Superheater Header and Regulator, manufactured by the Superheater Company, Ltd., 195, Strand, London, through whose courtesy we are able to reproduce a drawing and a perspective view, which show the arrangement very clearly. It will be seen that a long steam-chest is formed in front of the superheater header. In this chest there are two or more, as required, poppet valves, each provided with a balancing piston; one of the valves is much smaller than the others; it is a pilot. The regulator—altogether, the total increase of weight on the engine wheels will not be great, as the addition to the header only weighs, we are informed by the Superheater Company, 3 cwt. or so on a normal 7 cwt. header. The only ground for objection on that score would be the concentration of weight at the front end, and it may be safely said that in very few designs could it make any appreciable difference. As a matter of fact, quite a large number of engines have already been fitted; Armstrong, Whitworth and Co., Ltd., are just completing two groups of boilers provided with the apparatus for the Bengal-Nagpur Railway, and the North British Locomotive Company, three locomotives for the F.M.S.R. We understand, too, that the London and North-Eastern Railway, which is always ready to try promising developments, is having an engine fitted with it.

We have alluded to the advantages, but there are two, at least, which will especially attract the locomotive men. The first is that in all probability it should prove easier to keep poppet valves tight than a normal regulator of the slide valve or double beat type. It is a troublesome job to get at a regulator, as it means the removal of the dome. But in this case the valves can be easily got at through the covers, and as a trap is provided in the crown of the smoke-box, the job is scarcely even an awkward one. Then there is the other advantage that live superheated steam is available the moment a valve is opened. It has not got to travel along a steam pipe and through the superheater, but is there on the spot, so to speak. That fact ought to make the handling of the engine easier. Finally, it may be noticed that as one, two or three valves may be open at a time as desired, there should be very rarely any need to have a valve half open, and wire drawing across a valve seat, which takes place with all dome regulators, with its attendant wear, should be avoidable. Altogether it is a really attractive invention, and unless some hitherto unseen snag is met, we shall expect to see it widely employed.



THE M.L.S. SUPERHEATER HEADER AND REGULATOR



SECTIONS THROUGH SMOKE-BOX SHOWING POSITION OF M.L.S. HEADER AND REGULATOR

THE transfer from Fleetwood to Heysham, of the Belfast steamship services of the London, Midland and Scottish Company, has now been fixed for April 30th—a week earlier than announced on page 179 of our issue of February 17th. W. Denny and Brothers, of Dumbarton, have supplied three new twin-screw steamers—the "Duke of Lancaster," the "Duke of Argyll," and the "Duke of Rothesay"—the last of which was launched on March 22nd. These vessels have a speed of 21 knots.

Institution of Mechanical Engineers.

SOUTHAMPTON MEETING, 1928.

THE summer meeting of the Institution of Mechanical Engineers will be held in Southampton and will begin on Monday, June 25th. The meeting will include a visit to Portsmouth. A local Reception Committee has been formed under the chairmanship of the Worshipful the Mayor of Southampton (Councillor Mrs. L. M. Foster Welch, J.P.), and includes members of the Institution and other ladies and gentlemen resident in Southampton and neighbourhood. Mr. Harry Parsons (Member) has been appointed Deputy Chairman of this Committee. Professor W. W. F. Pullen (Member) and Mr. F. Woolley have kindly agreed to act as Joint Honorary Local Secretaries. The business meeting and the secretarial office will be at the Chantry Hall, St. Mary's, Southampton.

PROVISIONAL OUTLINE PROGRAMME.

Monday, June 25th.—Arrival in Southampton.

Tuesday, June 26th.—Morning, the Worshipful the Mayor of Southampton and members of the Local Reception Committee will receive and welcome the President, Mr. Richard W. Allen, C.B.E., the Council and members of the Institution with their ladies, in the Chantry Hall. Reading and discussion of paper. Luncheon on board ss. "Homeric," by invitation of the White Star Line. Afternoon, alternative visits to works. Evening, reception and dance in the Pier Pavilion, by invitation of the Worshipful the Mayor and Corporation of Southampton.

Wednesday, June 27th.—Morning, alternative visits to either the Southern Railway Company's locomotive works or their carriage and wagon works at Eastleigh. Afternoon, alternative visits to either John I. Thornycroft and Co., Ltd., or other works or excursion to Romsey and Winchester. Evening, Institution dinner in the South-Western Hotel.

Thursday, June 28th.—Morning, alternative visits to works in Southampton; luncheon in the Pier Pavilion. Afternoon, either visit to works or excursion in the New Forest and visit to Beaulieu Abbey, by invitation of Lord Montagu of Beaulieu, K.C.I.E., C.S.I., V.D. (Companion). Evening, supper dance in the South-Western Hotel.

Friday, June 29th.—Whole-day visit to Portsmouth. The railway companies of Great Britain have kindly agreed to issue reduced price railway tickets to Southampton at a single fare and a-third for the return journey, from any station in Great Britain.

COOPERS HILL WAR MEMORIAL PRIZE AND MEDAL.

THE Coopers Hill War Memorial Prize, which was founded by members of the Royal Indian Engineering College, Coopers Hill, in commemoration of members of the College who fell during the war, is awarded annually by the Institution of Civil Engineers and triennially in turn by the Institution of Electrical Engineers, the School of Military Engineering, Chatham, and the School of Forestry, Oxford. The prize, which consists of (*a*) a bronze medal, (*b*) a parchment certificate of award, and (*c*) a money prize of the value of about £25, is awarded for the best paper on a professional subject selected by the Council making the award.

The triennial award falls this year to the Council of the Institution of Electrical Engineers, which has selected the following nine subjects, and members are invited to submit for consideration a paper on any one of them:—(1) "The Use of Electricity in Public Works;" (2) "Hydro-electric Power in Rural Districts;" (3) "Electrification of Railways;" (4) "Electricity in Agriculture;" (5) "Electric Railways in the Empire Overseas;" (6) "The Line and Wireless Communications of India;" (7) "Overhead Lines in Rural Districts;" (8) "High-voltage Cables (20 kV and upwards);" and (9) "Empire Wireless Communication." Papers submitted must be specially written for the purpose of the competition and reach the Secretary of the Institution not later than October 1st, 1928. Only corporate members of the Institution who were under thirty years of age on January 1st, 1928, are eligible.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Quiet Conditions.

TRADING conditions in the Midlands and Staffordshire remain quiet with no marked increase of activity in any branch of the iron and steel industries. There was a fairly large attendance on 'Change in Birmingham to-day —Thursday—but the amount of business transacted was relatively small. The chief complaint at present is not so much the lack of orders as the smallness of tonnages involved. The recently noted more hopeful feeling existing in engineering circles hereabouts has been stimulated by the Board of Trade returns for February, which seem to indicate more promising opportunities for trade.

Steel Business.

Some of the steel mills are doing a little better, but business is not evenly distributed. The general outlook for the trade is more promising, and steel works on the whole are making good time, but profit-making is practically impossible, owing to the fact that such small tonnages are ordered that the proportion of roll changing is excessive. There is a more active inquiry for native structural material. Midland constructional engineers are finding themselves in possession of a good volume of inquiries, and the spring trade now appears to be opening up. The rolling stock firms should require considerable material in the near future, while the Black Country tube trade is busy and using large tonnages of steel, as well as iron strip. Some acceptable orders have recently been received from this quarter. Native steel prices remain unchanged, but foreign quotations continue to increase, so that the position is gradually changing to the benefit of home producers. Foreign steel joists are now up to £6 2s. delivered April. Midland consumers will not place orders at this figure, but some little business is being done with merchants, although for the most part they are waiting until prices fall as they expect. Of this there is no sign at present. Foreign semi-finished material offers no advantage over British in this district, but in South Wales where rail costs are avoided, through its position on the seaboard, there is still a little advantage in taking Belgian sheet bars and billets. Birmingham merchants report a continuance of the buying of steel scrap. They now quote £3 2s. 6d. delivered South Wales, but it is maintained by purchasers that £3 is still accepted.

Pig Iron.

Although pig iron makers on the North-East Coast have been bold enough to raise the price of No. 3 Cleveland pig from £3 5s. to £3 6s. at furnaces, it must be realised that the conditions which led up to the advance in Cleveland have no counterpart in the Midlands. There, it would appear, sales have so far exceeded output since Christmas that the stocks which were a drug on the market have now been reduced to a practicable level, and there is some difficulty in getting early deliveries. Here, however, supplies are ample. Smelters find it no easy matter to dispose of their current output, for specifications are coming in but slowly against contracts. In addition to current output there are stocks at many of the furnaces, stocks of such size as to cause considerable uneasiness to producers who are endeavouring to maintain prices at their present level. Many are much tempted to offer price inducements to secure much-needed orders, but they are resisting remarkably well. The price generally asked for Northamptonshire No. 3 is still £3. Derbyshire makes are steady on the basis of £3 4s., with 6d. more conceded in particular instances. Hematites are still plentiful. Mixed numbers from the East Coast have been obtainable in this district at about £3 9s. on rail. Forge iron is still being inquired for at rates not far short of those lately quoted. Inquiries are too sporadic to inspire much confidence, however.

Staffordshire Bar Iron.

Finished iron business shows very little improvement, though the mills engaged on marked bars and special grades are fairly well employed. Trade is moving somewhat erratically. There is no reserve of orders, or only a small reserve, and as the volume of incoming business is precarious, mills have great difficulty in maintaining regular production. Some Staffordshire iron masters are again becoming pessimistic, for viewing the future in the light of recent experiences, it is far from cheering. Prices are nominally unchanged from last week, the gap between Staffordshire makers' and outside competitors' prices for Crown iron remaining as wide as ever. The tube trade is consuming fair quantities of strip, for which it readily pays £11 10s. per ton. Black Country makers of bolts and nuts are less active in the oversea markets, so far as shipments go, but they are increasingly busy on home account. Unfortunately, they are not increasing the proportion of native material used, and few orders come to Staffordshire makers, whose price of £9 per ton is still £2 10s. above Belgian quotations for No. 3 iron, used for similar purposes.

Sheet Values Depreciate.

Values of 24 gauge galvanised corrugated sheets have this week fallen by half a crown per ton, for though a few makers adhered to late quotations, others, anxious to assure the forward position, offered supplies at £13 5s. to £13 7s. 6d. per ton. Delivery in three or four weeks was offered. It was reported that there has been a decided falling off in export demand—the buying spurt has been short-lived—and mills have no great bulk of orders on their books.

Production Returns.

Midland industrialists draw some consolation from the fact that the returns of iron and steel production ior the past month record a slight rise in the daily rate of production, as compared with January, and that the number of blast-furnaces in blast has not further decreased. Otherwise the statistics make but poor reading, showing as they do production of pig iron to have amounted to 550,800 tons, compared with 560,500 tons in January and 571,100 tons in February, 1927. The February production includes 190,000 tons of hematite, 187,300 tons of basic, 130,000 tons of foundry and 23,300 tons of forge pig iron. Production of steel ingots and castings in February amounted to 764,400 tons, compared with 626,200 tons in January, and 826,800 tons in February, 1927. The number of furnaces in blast at the end of February was 148, the same as at the end of January. During the month six furnaces commenced operations and six ceased.

Large Rolling Stock Contracts for Midlands.

Midland rolling stock firms have just secured some excellent contracts from the London Underground Railways. They are very welcome, and they will materially assist in keeping the shops fully occupied during the coming months; moreover, they will entail the use of considerable quantities of iron and steel. The Birmingham Railway Carriage and Wagon Company, Ltd., is to supply 101 car bodies and 184 bogies for the District Railway; the Metropolitan Carriage, Wagon and Finance Company, Ltd., of Saltley, 112 new cars, 224 bogies and 170 car bodies for the Hampstead and City Railways, and a further 136 car bodies and 612 bogies for the Hampstead and City and Piccadilly Railways; the General Electric Company, Ltd., Witton, 538 traction motors for the District Railway, 128 traction motors and 127 control equipments for the Hampstead and City Railways, 116 traction motors for the Bakerloo Railway, and a further 266 traction motors for the Hampstead City and Piccadilly Railways; the British Thomson-Houston Company, Ltd., of Rugby, 263 control equipments for the District Railway, 57 for the Bakerloo Railway, and 67 for the Hampstead and City and Piccadilly Railways.

Coventry's New Power Station.

Coventry's new electric power station, a cornerstone of which was laid last week, is, when completed, presumably destined to play an important part in the future electricity supply of the Midlands. Mr. A. N. East, of the Electricity Commission, announced after the completion of the ceremony, that the Commissioners had been engaged in preparing a scheme for Central England, including Notts. and Stoke in the north, Northampton in the south, and taking in Coventry and Birmingham. That scheme was finally decided upon, and had been submitted to the Central Board and would be published during the coming week. They would then see what it had in it for Coventry, and he thought they could say that Coventry's new station would play a vastly important part in the future, and would have a vastly important future in the electrical supply for that area. The new power station is being erected at a cost, including the feeder cables and sub-station equipment, of approximately three-quarters of a million pounds, the contract being in the hands of the British Thomson-Houston Company, Ltd., of Rugby, and its completion will mark another step in Coventry's industrial progress.

Cannock Chase Coal Output Reduced.

An intimation, far from pleasant, has been received by Cannock Chase coalowners who are now working under the coal marketing scheme. The pits in this area are drawing too much coal, and an order has been issued for the curtailment of production of a certain percentage. It is understood that instructions have been issued in the local area that the output is to be reduced by 20 per cent. The control of the output of the pits to prevent too great a flood of fuel on the markets is, of course, one of the fundamental features of the scheme, but local coalowners, many of whom have of late years introduced new modern plant for increasing productive resources, hardly anticipated they would be called upon so early to refrain from putting to full use this costly additional machinery. The news has caused considerable uneasiness in the coalfield.

Unemployment.

Following the substantial decrease of 4326 last week in the return of unemployed in the Midlands, the latest figure also records a continued improvement, with a slight drop of 456. The total for the principal towns now stands at:—Birmingham area, 25,619; Bilston, 2450; Coventry, 3349; Cradley Heath, 3340; Derby, 1859; Dudley, 2602; Leamington and Warwick, 626; Leicester, 3381; Northampton, 1599; Nottingham 5823; Oldbury, 856; Peterborough, 752; Redditch, 1048; Smethwick, 2918; Stoke-on-Trent area, 12,940; Stourbridge and Brierley Hill, 2411; Tipton, 1650; Walsall, 4265; Wednesbury, 1852; West Bromwich, 2376; Wolverhampton, 3570; Worcester, 1238.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Exports of Textile Machinery.

SHIPMENTS of British textile machinery during February, although considerably greater both in quantity and value than in the corresponding month of last year, were much below the level of the opening month of the present year. To some extent, though not entirely, this reduction may be attributed to the fact that February had fewer working days than in January. In the aggregate, exports of textile machinery last month were valued at £894,987, compared with £1,079,788 in the previous month, and £824,949 in February, 1927, the respective quantities being 9674 tons, 10,842 tons, and 8588 tons. Of last month's total value, shipments of spinning and twisting machinery accounted for 6930 tons and £666,819, and of weaving machinery for 2272 tons and £165,476. British India continued to be by far the most important individual market, exports thence during the period under review reaching a value of £214,921. Second in importance, although far behind India, came Germany, with £80,593, followed by Russia with £61,664; France, with £61,092; the Netherlands, with £60,838; South America, with £47,790; Japan, with £47,475; the United States, with £45,466; Australia, with £12,075; China, with £7977; and "other European countries," with an aggregate of £206,463.

Million-Volt Arcs.

A demonstration of the production and control of a million-volt arc was carried out at the works of Ferranti Ltd., at Hollinwood, on Monday, before engineers of the Central Electricity Board. The primary object of the experiments was to demonstrate the manner in which insulators used to carry high-tension cables would act in thunder storms. A similar demonstration was conducted by Messrs. Ferranti about two years ago.

Underground Railway Scheme.

The report of the special Underground Railways Committee of the Manchester Corporation, which was remitted by the City Council some months ago to the Tramways and Finance Committees of the Corporation, came under the consideration of the former body this week, and it was decided to refer certain points back to the Underground Railways Committee for further information. It may be recalled that the scheme in question relates to the construction of about 16 miles of underground railways to serve Manchester and certain suburbs, the estimated cost being about £11,000,000.

Motor-Omnibuses for Salford.

At the last meeting of the Salford City Council a resolution of the Tramways Committee accepting tenders for the supply of twenty-four standard four-wheeler 32-seater motor-omnibuses, at a total cost of £29,947, was confirmed.

Non-ferrous Metals.

Except for a remarkable recovery in the tin section and a further weakening in spelter, the non-ferrous metals market has provided few noteworthy features during the past week. From the lowest point of the year at which the tin market closed a week ago, values at the time of writing have fully regained the ground lost in the previous week, and current quotations are several shillings a ton higher than they were a fortnight ago. To a very large extent the recovery here has been due more to outside influences than to any domestic improvement in the demand for the metal, although the turnover on this side during the past week has been on a bigger scale. The most important factor in the price situation has, however, been the renewed buying movement in the United States. Naturally the tone of the market at the moment is better than before, but whether it is likely to continue is problematical. At all events, a good deal will depend upon developments in other consuming countries, and, of course, upon speculative activities. With regard to copper the position is much the same as at last report, with values on balance fractionally easier than they were a week ago in the case of standard metal, refined descriptions keeping fairly firm. The demand for the metal, both here and in continental centres, is at present only on moderate lines. Buying interest in lead and spelter has been relatively quiet. The former, however, has kept up very well, and prices are not quotably changed compared with a week ago. In the case of spelter, for the second week in succession there has been a weakening tendency.

Iron.

Although there has been no decided alteration in the position of pig iron on the Lancashire markets, the general feeling seems to be in favour of a somewhat brighter view of the outlook. From the point of view of sellers' margins, which, in many cases, are at an unprofitable level, conditions at the buying end have not been favourable to an advance in Midland varieties of foundry iron consonant with that reported a week ago in North-East Coast makes. There has, however, been a perceptible further steadying of the market, and as stocks at the blast-furnaces during the last few weeks have become less of a "bogey," weak selling is not so much in evidence. Current buying operations this week have been rather quiet, but sellers are hopeful that a good proportion of the forward inquiries for pig iron that are in circulation will reach the order stage. Meanwhile, for delivery Manchester or equal, Derbyshire No. 3 is quoted at 72s. 3d. per ton, Staffordshire at 71s. 6d., Cleveland at 79s., Scottish from 86s. upwards, and hematite at about 84s. per ton. A continued quiet and relatively unsatisfactory demand for manufactured iron is reportrd, but prices of the Lancashire Association have been adhered to, Crown quality bars being quoted at £10 and seconds at £9 10s. per ton.

Steel.

The bulk of the steel buying this week has been for moderate parcels for near delivery, and few orders of outstanding importance have been reported. Constructional engineers in the district are kept fairly active in most instances on work in hand, and inquiries in this branch of engineering have been rather more numerous than of late. Business in boiler plates is apt to be very patchy still, although one or two specifications for moderate quantities have been given out. The demand for steel bars has been rather quiet. Large diameter bars are unchanged at the Association figure of £8 17s. 6d. per ton, and the small re-rolled sorts, except for isolated instances of undercutting, are fairly steady at about £7 12s. 6d. Boiler plates are quoted at about £9 15s. per ton for basic sorts, and £10 to £10 5s. for acid plates, with joists and sections at £7 17s. 6d. and tank plates at £8 12s. 6d. per ton. There is not a great deal of business offering just now in the case of imported steel, and here and there is evidence of a slight

easing off. Continental billets, for delivery to works here for cash against shipping documents, are quoted at about £5 7s. 6d. per ton, with sheet bars at £5 12s. 6d. to £5 15s., joists at £5 17s. 6d., angles at £6 7s. 6d., wire rods at £6 15s., and Siemens plates at £7 15s. to £7 17s. 6d.

BARROW-IN-FURNESS.

Hematite.

The state of the hematite pig iron market in the West Coast district is causing considerable disquiet. There is still no sign of an improvement; in fact, many brokers are wondering where their trade has gone. It would appear that competition, both home and continental, is affecting makers in this district, and how long this competition will be maintained it is impossible to say at the moment. Much shipbuilding is going on in the country, generally speaking, and one, in the face of it, would think that that would mean a call for iron, but in this particular industry continental material is playing an important part. Fortunately, the steel departments are engaged at Barrow and Workington, and both are taking a considerable output of iron. The amount of business that is done in this district consists mostly of small parcels to meet immediate requirements. There is very little forward booking; in fact, it is so small it is not worth talking about. The Midlands are the best customers; the next best, perhaps, is Scotland. South Wales is taking a moderate quantity. Stocks are not coming down very rapidly. In the iron ore trade there is naturally a certain amount of quietness owing to the restricted local demand, and the fact that there is not much business outside the district. The demand for foreign ore is very small. The steel works at Workington are again employed this week in most of the departments. At Barrow, the rail mills are still running, as also are the merchants and Siemens departments. In both cases fresh orders are urgently needed.

SHEFFIELD.

(From our own Correspondent.)

The General Position.

IMPROVEMENT is to be noted in some departments of the steel trade, but it is offset by declines in others, and, while a very large volume of work is being done in the city, there is no evidence of general expansion. The heavy steel trade is better as the result of increased continental prices, which have enabled local firms to secure new customers for lower quality billets, but, although the contracts placed are good, specifications in connection with them are rather disappointing. There is an improvement in railway steel, and the plants are better employed than they have been for a considerable time. On the other hand, the sections of trade supplying the motor industry are not enjoying an activity equal to that of recent years. They are pretty busy on orders for commercial vehicles, but the requirements of steel and tools for touring cars show a falling off. The demand for best tool steels keeps well up to recent levels, but is below the pre-war standard, on both home and export account. The wire rod trade is seriously affected by severe foreign competition at very low prices, and on this account William Cooke and Co., of Tinsley, have suspended the rolling of rods at their own works, and are concentrating all their activities in this branch at the Templeborough Rolling Mills, of which they are one-third owners. These mills are equipped on the most up-to-date lines for economical production, and are securing an increasing amount of trade.

Some Encouraging Reports.

Several local firms have issued reports or dividend announcements during the week, all of which show an improvement and encourage hopes of confidence in the future. Vickers Ltd. announce a dividend on the ordinary shares after a lapse of four years. The distribution is at the rate of 8 per cent. The shares are, of course, of the 6s. 8d. denomination, having been written down from £1 under the reorganisation scheme. Hadfields, Ltd., report that, while the coal, steel and general engineering trades are still very depressed, there has been an improved demand for a number of the special products of the company. The year's profit was £187,223, as compared with £68,876 in the previous year, and the dividend is raised from 2½ to 5 per cent. John Baker and Co., Ltd., of Rotherham, who are largely engaged in the manufacture of railway material, are able to pay a dividend on the ordinary shares—5 per cent.—for the first time in three years. The directors state that "full advantage was taken of the period of activity at the beginning of the year. During this period, which unfortunately lasted only to the end of August, the output from the works far exceeded any previous record, and yielded a satisfactory profit." Henry Bessemer and Co., Ltd., who are also makers of railway materials, had an improved year, and made a profit of £11,312 in 1927, as against a loss of £27,667 in 1926. They report that the works were well employed during the greater part of the year, and that the output was considerably larger than for several years past, though the downward tendency of prices continued.

Solid Forged Drums.

The solid forging of steel drums for high-pressure boilers is a recent innovation in steel works practice, and is being carried on by several large firms, including John Brown and Co. and Vickers-Armstrongs. The process employed is ingenious and difficult, and has necessitated the installation of special plant of a rather elaborate nature. For a good many years the drums of turbines have been rolled hollow in a single piece from ingots, but, although these drums are of large diameter—running up to 14ft.—they are short, while solid boiler drums have been forged up to a length of 40ft. Last year John Brown and Co. produced nearly a hundred drums of this character, several of which were for large generating plants abroad, and they will be making nearly as many this year.

Cutlery and Plate.

Conditions in the cutlery and plate trades are unequal, for while some firms are well employed, others report that business has fallen off and that the volume on hand is considerably less than in January. The aggregate output is large, although the requirements of the sixpenny bazaars show a substantial falling off. Several large contracts for tableware are being carried out. The scissors trade shows a marked improvement. The celebrated firm of Joseph Rodgers and Sons, Ltd., had its annual meeting last week, when the chairman, reviewing the past year's trading, said that there had been a great improvement, and that the company had been able to increase its turnover by a considerable amount. He added that the economies and alterations commenced during 1926 had resulted in important savings and increased efficiency at the works.

A Chamber of Commerce Success.

Credit is due to the Sheffield Chamber of Commerce for the steps it took in the interest of the steel trades when the new Spanish tariff proposals were recently introduced. Information has now been received from General Primo de Rivera that the duties on steel will not be increased. A member of one of the firms interested in the matter states that this result is no doubt due to the efforts of the Chamber of Commerce. That body sent to the Board of Trade a definite statement regarding the effects of an increase of tariff on certain classes of steel, and followed it up by individual efforts on the part of members of the Chamber. As far as it knows, the Sheffield Chamber was the only organisation to raise any discussion on the matter. Of course, it does not follow that any of the present restrictions are to be removed, but it does mean that Sheffield traders can look forward to a period of stabilised trade on the existing tariff.

A Good Word for Bricklayers.

After all the unfavourable criticism that one has heard with regard to the output of English bricklayers, it is interesting to have a good report from a specialist who is able to compare English workmen with American. The specialist is Mr. T. Rainbow, who is superintending the erection of a battery of coke ovens which the Woodhall-Duckham Vertical Retort and Coke Oven Construction Company, Ltd., is installing for the Nunnery Colliery Company at Handsworth, Sheffield. The work is different from other classes of bricklaying, for 440 different shapes of brick are used in the construction of one wall. Mr. Rainbow states that the Sheffield bricklayers compare very favourably with those who are engaged on the same class of work in America. The ovens, which are being built of silica bricks, are 40ft. long, 12ft. 6in. wide, and have a mean width of 14in. The plant will carbonise 520 tons of coal per day, and surplus gas to the extent of 4,000,000 cubic feet per day will be supplied to the city.

Big Road Scheme Started.

A beginning has now been made with the construction of a road from High Green to Hangmanstone, Birdwell, which will provide a new and improved route for traffic between Sheffield and the North of England. One of its chief advantages will be the cutting out of the dangerous Chapeltown Hill. The road will be about 2¾ miles long, and will cost upwards of £120,000, of which three-quarters will be contributed from national funds. There will be no steep gradients, and the distance will be only a few hundred yards greater than that of the existing route from Sheffield to Barnsley. It is expected that the work of construction will take about two years. Sufficient land has been bought to allow of a width of 80ft. between the fences, and it is understood that the carriageway will be widened from time to time as traffic warrants it.

NORTH OF ENGLAND.

(From our own Correspondent.)

More Naval Work for the Tyne.

MORE important naval contracts have been placed on Tyneside. They relate to the machinery in connection with the new building programme of the Admiralty. Recently Swan, Hunter and Wigham-Richardson, Ltd., Wallsend, were given an order for the machinery of a flotilla leader. A contract for two destroyers was secured by Hawthorn, Leslie and Co., Ltd., and the orders for six similar vessels were placed in other shipbuilding centres. It is now announced that the Wallsend Slipway and Engineering Company, Ltd., has secured the order for the flotilla leader itself, and that Hawthorn, Leslie and Co. will supply from their St. Peter's Works the engines for the two destroyers which the firm will construct at the Hebburn shipyard. An even more important order, however, is that for the turbine machinery of the new light cruiser to be built at Devonport Dockyard, which has gone to Parsons Marine Steam Turbine Company, Ltd., Wallsend. At the present time all the engineering works on the Tyne could easily accommodate more work, and therefore the new contracts will improve their prospects for at least some time ahead.

Cleveland Iron Trade.

Business continues to develop along steady lines in the Cleveland pig iron trade, and the outlook generally is encouraging. Sales to cover summer requirements are reported, but consumers are disinclined to commit themselves extensively further ahead. Purchasing of foreign iron for consumption in this district has shrunk to very small proportions, and deliveries from abroad in fulfilment of old contracts have become so irregular as to cause considerable inconvenience to customers and to necessitate, in some cases, prompt buying of local products. Stocks of Cleveland pig iron are still being drawn upon, notwithstanding increased production by the recent blowing-in of an additional furnace at the works of Bolckow, Vaughan and Co. Makers report that the shilling advance has not kept buyers off the market. Business with some customers in other districts shows some improvement, and further sales to Scotland are reported. Transactions with firms north of the Tweed since the establishment of the central selling agency for the Scottish trade are understood to amount to many thousands of tons, and the business is stated to be unaffected to any material extent by the competition of Lincolnshire and Northamptonshire firms. Cleveland iron prices are steady and firm, No. 1 foundry being 68s. 6d.; No. 3 G.M.B., 66s.; No. 4 foundry, 65s.; and No. 4 forge, 64s. 6d.

Hematite Pig Iron.

Conditions in the East Coast hematite pig iron trade are still very unsatisfactory. Some slight improvement in both home and continental demand is reported, but the supply is still more than ample, notwithstanding the reduced make, and values, though tending upward, are not quotably altered. Market rates remain on the unremunerative level of 70s. per ton for mixed numbers.

Ironmaking Materials.

The foreign ore trade presents no new features. Sales are very few, but sellers are as firm as ever in their attitude. Quotations are based on 22s. per ton c.i.f. Tees for best Rubio ore. The strike of ore miners in Sweden still continues, and there seems to be little hope of an early termination of the dispute. Durham blast-furnace coke is in poor demand. Supply is fairly plentiful, but users are not disposed to negotiate for extensive quantities. Good average qualities are offered at 18s. per ton delivered to consuming works in this area.

Manufactured Iron and Steel.

In the manufactured iron and steel trade aggregate output is heavy, but while certain branches of the industry are busy, in other departments the plant is far from being fully occupied. Rather considerable transactions in semi-finished steel are reported, and the demand for some descriptions of finished steel is a little better, notwithstanding that several continental competitors are once more quoting for early delivery. Quotations show no movement.

The Coal Trade.

There is very little movement in the Northern coal trade, but with so many pits idle and others about to close, the prospects of smaller supplies cause some anxiety amongst operators who have committed themselves ahead. The Northumberland collieries appear to be determined to adhere to the present range of fixed prices, being convinced that, if they receded in ever so small a degree, still further concessions would be asked by consumers abroad. They believe that there is a limit to what Poland can do as a competitor in Scandinavia and elsewhere, under her present subsidies from the Government, and that costs are rising in the Ruhr. It may mean idle days at Northumberland pits, but selling at a loss has got to stop. Details of the Swedish State Railway's coal contract—an order that invariably came to Northumberland in years gone by, but has been almost entirely lost in the latest tendering—show very low prices and high guarantees as to quality. With the exception of one cargo in the 93,000 tons which Poland secured, the coal is guaranteed to hold a minimum of 7400 heat units, and for each 100 units below that guarantee a reduction of 2½d. per ton is allowed. The Swedish Railways, it is stated, have not paid such low prices for their coal since 1911. Another coal contract which invariably comes to this district has been lost in the severity of foreign competition. The contract for the supply of 10,000 tons of gas coals to Athens Gasworks has gone to Germany at 21s. 9d. per ton c.i.f., delivery to be in April and May. The lowest tender from this district was at least threepence above that figure. Tenders for the supply of 35,000 tons of steam coals to the Norwegian State Railways have been sent in, but there is not much confidence about getting the order, having regard to the low prices of Polish competing coals. Some merchants, in fact, have not tendered this time, as they believe their figures would have no chance of acceptance. So far as the market position is concerned, there is no outstanding item giving any encouragement of an improved demand setting in. New business is difficult to attract, but some grades of coal show a slightly steadier tendency in value. This has been brought about by the curtailment of output through several pits closing down, and the "ca' canny" methods adopted by putters in many instances. The undercutting of prices in the steam coal trade is being severely felt in Northumberland. Best steams are maintained at 13s. 6d., with seconds at 12s. Gas fuel has a market of a less restricted kind, although in this section also the competition is very keen. Supplies are freely offered, but prices are steady at 15s. to 15s. 6d. for best qualities, and 13s. to 13s. 3d. for secondary qualities. There is a good demand for first quality bunkers, which are firm at 13s. 9d. to 14s. 9d., but ordinary kinds are neglected at nominally 13s. 3d. There is very little demand for the surplus production of patent oven cokes, and prompt buyers can discount 17s., but this figure is steadily quoted forward for good average qualities. Beehive coke is quiet and unchanged at 25s. to 28s. Gas coke is offered freely, but new business remains scarce, and quotations remain at 21s. to 21s. 6d.

North-East Coast Exhibition.

In the presence of a large and representative gathering of Northern industrialists and the heads and members of boroughs in the area, the Duke of Northumberland on Wednesday cut the first sod on Newcastle Town Moor in connection with the North-East Coast Industrial Exhibition, to be held next year. The Duke, after cutting the sod, remarked: "We have done something much more important than cutting the first sod. We hope and believe we have laid the foundation stone of the future prosperity of Newcastle, Tyneside, and the North-East Coast. We are determined to show that we are not discouraged by the hard times which we are passing

through, and that the prosperity which the North of England enjoyed at one time shall not be transferred to the South of England." Space to the value of £28,000 has now been booked.

SCOTLAND.

(From our own Correspondent.)

Steel.

ALTHOUGH there is an improving tone in some sections of the steel trade, the general position has not appreciably changed. Local producers gained some encouragement from the recent firmness of continental materials, but latest advices indicate a reactionary movement, and while it may only be temporary, it has not been without its effect on home markets, and there is now less confidence in the future aspect. Meanwhile, business is mainly of a hand-to-mouth character. Home consumers generally are only buying moderate quantities, and exports are meagre. Consequently outputs are still considerably below the capacity of the works. Plates and sections are dull. Heavy black sheets are rather short of orders, and specifications for galvanised sheets are not plentiful. Prices are unchanged. Scrap material is firm, heavy steel being quoted about 65s. per ton.

Iron.

Continental competition is still a potent factor in the iron trade. Bar iron is most inactive, and the re-rolled steel branch of the industry is not much better off. Home prices are unchanged at £10 5s. per ton for bar iron and £7 15s. per ton for re-rolled steel, with export about 10s. and 15s. per ton lower respectively.

Pig Iron.

The slightly firmer tone of pig iron is maintained, and some grades of foundry are inclined to appreciate. On the whole, however, in the absence of business, the market shows little change. Hematite, 74s.; No. 1 foundry, 75s.; and No. 3 foundry, 70s.—all per ton for home delivery.

Tubes.

The demand for tubes is somewhat irregular. Producers of lapwelded descriptions are short of orders, but butt sorts are comparatively busy.

Exports and Imports.

During the past week 4860 tons of iron ore, 2500 tons of pyrites, 1550 tons of iron, and 1000 tons of pig iron, the last-named from India, were discharged at Glasgow. Iron and steel products to the amount of 6700 tons were dispatched to Australia, South Africa, India, China, Japan, Java, and Brazil. Fair quantities of structural material, tubes and machinery were also exported.

Coal.

The coal trade is without improvement. Shipping demands are meagre for prompt and almost non-existent for forward delivery. The item of interest during the week was the announcement regarding the Swedish State Railways' contracts, and the fact that, despite low quotations for Scottish fuel, all the contracts, with the exception of 10,000 tons of English coal, had been secured by Poland, is a fair reflex of the present situation. The dearth of shipping orders is most keenly felt in the eastern districts, and there is a strong possibility that some collieries will take advantage of arrangements under the scheme to deal with the present stagnation, and may close down meanwhile. This appears to be the case especially in Fifeshire, which county, along with Kinross and Clackmannan, has been severely hit by the lack of foreign business. Collieries wishing to close have been asked by the Committee in charge of the scheme to submit applications to that effect. Aggregate shipments from Scottish ports during the past week amounted to 237,026 tons, against 203,868 tons in the preceding week, and 246,238 tons in the same week last year. Supplies of fuel for home consumption are ample, and collieries find some difficulty in securing the extra 6d. per ton for household fuel and the additional 1s. 6d. per ton on fuel for general public utility concerns and railways arranged for in the scheme to stimulate the trade.

Colliery Losses.

During the month of January this year the average price for all classes of coal, f.o.b. at Scottish ports, was 13s. 3d. per ton. If an average of 3s. per ton is deducted for railway rates and dock dues, 10s. 3d. per ton is left, against a cost of 12s. 2d. per ton for bringing coals, large and small, to the surface, representing a loss of 1s. 11d. per ton.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

THE position so far as the anthracite trade is concerned is far from satisfactory, and continues very dull. Conditions in the steam coal section are, for the moment, in rather marked contrast, and while they cannot on the whole be described as good, seeing that values are so unremunerative, it cannot be denied that shipments are on quite an active scale, and the probability is that the current month will turn out to be the best from the export point of view for a considerable time past. If only the anthracite section displayed reasonable activity, the returns for the whole district would be highly satisfactory. For the week ended the 16th inst., the total exports came to the respectable figure of 510,434 tons, which compared with 451,214 tons for the preceding week. There is reason to believe that the current week's returns will turn out well, as although at the end of last week there was a total of just over thirty-two idle loading appliances at the various docks, arrivals of steamers over the week-end improved the situation, and on Monday the report was that while sixteen loading appliances were at a standstill, there were nine steamers waiting. Good loading work is being accomplished, and certainly the majority of the leading colliery undertakings are busy. Nevertheless, the market for coals displays extremely little real life. The probabilities are that shipment conditions will continue to be fairly good up to the Easter holidays, but beyond this it is difficult to say, as current operations in the taking up of tonnage are somewhat slow and the inquiry for supplies ahead presents no feature. Still, there is a moderate demand for tonnage, but merchants are not experiencing difficulty in satisfying their requirements. Not only are colliery undertakings having a very lean time, but shipowners are sharing in it to a marked degree. Freight rates are down for all directions, and Rio de Janeiro has been done at 9s., a rate which has not been touched since years before the Great War. The worst of it for owners is that they are unable to find any compensation in homeward business, the result being that many steamers are being laid up temporarily.

Colliery Amalgamation.

Official news was forthcoming early this week concerning the amalgamation proposals of the Powell Duffryn Company, about which rumours have been in circulation for some time. A circular has been issued which points out, after referring to the offer made by the directors to the shareholders in the Great Western Colliery Company, that a conditional contract has been entered into with the receivers of the Lewis Merthyr Consolidated Collieries, Ltd., whereby the Powell Duffryn Company has agreed to purchase for cash certain properties of that company. This contract is, of course, subject to confirmation by the court, and subject to satisfactory terms being arranged with the mineral owners. The acquisition of the Great Western and Lewis Merthyr properties will give the Powell Duffryn company the control of an additional output of coal of approximately 3,000,000 tons per annum, together with an increased yearly output of about 100,000 tons of coke and a valuable extension of the company's by-product activities. In addition, steps have been taken whereby a closer working arrangement has been come to with the Cardiff Collieries, Ltd. There is to be an extraordinary meeting of the shareholders of the "P.D." company on the 27th inst. for the purpose of authorising an increase of capital by £2,500,000 and the increase of the directorate to twelve. If the proposals mature, it will mean that the Powell Duffryn Company will eventually control an output per annum of about 10,000,000 tons of Welsh coal of superior quality, apart from by-products of an extremely important character.

Government Assistance.

The joint deputation of owners and workmen's representatives which waited upon the Government on the 9th inst., with reference to the matter of high railway rates, dock charges, local rates, &c., met on Monday and again considered the position in the light of its interview with the President of the Board of Trade. It was decided to communicate with the Prime Minister asking for the Government's decision with respect to the representations made.

Steel Pit Props.

At the annual meeting of the South Wales Institute of Engineers, held at Cardiff at the end of last week, the President, Mr. William O'Connor, F.G.S., announced that a member of the Council had offered £20 for the best design of a steel prop, suitable for use in the steam coal seams of South Wales. He said that unfortunately the majority of accidents in the mine still came in the category of roof falls, and anything that could be done to minimise that risk and keep the coal faces in good condition would be well worth doing.

Current Business.

Day-to-day business is on the quiet side, and yet the majority of the collieries are very well placed for prompt loading. In the case of the best Admiralty large coals 19s. 3d. is the lowest figure quoted, and one or two are asking for 19s. 6d. They are in the fortunate position of being fully sold for the next fortnight. Inferior large coals are not so well booked up, but small coals are very steady, and the same applies to sized coals. The market for coke displays little alteration, while patent fuel shows no new feature.

INTERNATIONAL COMMISSION ON ILLUMINATION.

IN September next an important meeting of the International Illumination Commission, which was formed in 1900 and includes both the gas and electrical interests, is to be held in America. The objects of the Commission are the study of all subjects bearing on illumination and its cognate sciences, and the establishment of international agreements in illumination matters. There are at present National Illumination Committees in Austria, Belgium, France, Germany, Great Britain, Holland, Italy, Japan, Switzerland and the United States of America.

For the first time in the history of the Commission, a British President has been elected, Mr. C. C. Paterson, who is director of the Research Laboratories of the General Electric Company, Wembley, having been unanimously voted President at the Bellagio meeting in September, 1927.

The Commission has already established an international standard of light, and the following subjects are now being dealt with, to which will be added, from time to time, other important matters associated with the study and practice of illumination engineering which are ripe for international consideration :—Vocabulary, definitions and symbols, factory and school lighting, automobile headlights, heterochromatic photometry, street lighting, signal glasses, diffusing materials, photometric test plates, photometric accuracy, &c., light flux distribution, daylight illumination, cinema lighting, funamental research on glare, colorimetry.

The British National Illumination Committee, which is closely associated with the Sectional Illumination Committee of the British Engineering Standards Association, the membership being practically identical, and which will be responsible for nominating delegates to represent British views and British interests, is very anxious to secure adequate representation at these meetings. It is hoped that the delegates will include representatives of Government Departments, Municipalities, the National Physical Laboratory, the electrical industry, the gas industry, and the principal Associations interested in illumination matters, and an appeal is made to those bodies to provide the representation desired. Mr. Buckley, of the National Physical Laboratory, Teddington, who is the secretary of the British National Illumination Committee, will furnish full particulars.

CATALOGUES.

J. J. GRIFFIN AND SONS, Ltd., Kemble-street, Kingsway, W.C. 2.—Leaflet 16X on the improved Parr type sodium peroxide bomb calorimeter.

R. A. SKELTON AND CO., Ltd., Moorgate Station Chambers, E.C. 2.—Handbook 21, a book of over 200 pages giving full particulars of broad flange beams—grey process.

GALLOWAYS, Ltd., Knott Mill Ironworks, Manchester.—Particulars of the "Supermiser" for transferring the waste heat recovered to the feed water and furnace air supply simultaneously.

BRITISH INSTRUCTIONAL FILMS, Ltd., 39, St. James'-street, S.W. 1.—"Cinematography in Commerce," a booklet introducing the uses to which the cinematograph can be put for "safety first" campaigns, teaching apprentices, reports of works carried out, &c.

OXYGEN JET CUTTING.—There has of late been, we believe, some recrudescence of the discussion as to whether or not the cutting of steel by means of the oxygen jet affects its nature. Some engineers contend that the steel may be injured to a depth as great as ½in., while others claim that the effect is negligible, or non-existent. The latter school is supported by a sample we have just received from the Godfrey Engineering Works, of Boundary-road, London, N. 22. It is a strip cut, with a blowpipe, out of a ½in., 28-ton, mild steel plate. It is ⅞in. wide. This strip has been bent, cold, round a radius of ½in., which clearly shows that its ductility has not been destroyed, although the two cuts are so closely adjacent.

THE MACHINE TOOL TRADES ASSOCIATION.—Under the evergenial chairmanship of Sir Alfred Herbert, the Machine Tool Trades Association held its annual dinner at the Trocadero on Wednesday last. The company was a large one, practically all the men who have raised the modern British machine tool to the great position which it holds being present. An exceptionally long toast list dismayed experienced diners out, but Sir Alfred is not a chairman to let matters drag, and not one of the speeches was overlong or tedious. There was indeed more laughter than *ennui*. Mr. Harold Butler proposed "The Guests." Sir Henry Fowler replied, and amongst the other speakers were Sir Gerald Bellhouse, Sir Arthur Balfour, Mr. Nugent, Mr. Charles Wicksteed, and, of course, Sir Alfred himself. A good evening well spent.

THE BURMEISTER AND WAIN MARINE OIL ENGINE.—We have received from Burmeister and Wain, Ltd., of Copenhagen, booklets in English giving the contents of two papers which were read by Mr. H. A. Blache, the managing director of the firm, at meetings of Japanese engineers, shipbuilders and shipowners, which took place in Osaka in the autumn of last year. The booklets are excellently illustrated, and some interesting views of the firm's Copenhagen engine works and foundry are included, along with representative types of motor vessels constructed by the firm and its licencees. The main features of the Burmeister and Wain design and the processes of manufacture are dealt with, and Mr. Blache discusses the application of the double-acting four-cycle oil engine for larger powers, showing machinery arrangements for outputs of 50,000 and 100,000 S.H.P. on four screws.

INSTITUTION OF CIVIL ENGINEERS : ASSOCIATION OF LONDON STUDENTS.—The forty-seventh annual dinner of the Association of London Students of the Institution of Civil Engineers was held at the Holborn Restaurant on Friday last. Mr. J. R. Brock Griggs, chairman of the committee of the Association, presided. Mr. E. C. Trench, President of the Institution, replying to a toast to that body, proposed by Mr. H. G. Cousins, remarked that this year they were celebrating the centenary of their incorporation and the one hundred and tenth year of the Institution's existence. In the course of his duties he had, he said, visited a large number of engineering colleges in different parts of the country, and had learned that there was a growing appreciation of engineering among the leaders of industrial concerns. In fact, the colleges had no difficulty in placing all their students in suitable employment. That was a very encouraging feature. Mr. H. E. Steinberg, in submitting the toast, "The Students of the Institution," declared that the prestige of the Institution had been built up on the care taken to admit only students of the right type—men who possessed practical as well as theoretical knowledge of their work. The chairman responded. Mr. M. H. Elliott proposed "The Guests" Sir Cyril Kirkpatrick and Mr. R. A. Brockbank acknowledging.

ELECTRICALLY DRIVEN EXCAVATORS.—In connection with the article on the electrically driven excavators, which appeared in our issue of February 9th, Messrs. Ransome and Rapier have asked us to emphasise the distinctive characteristics of the motor combination which they have adopted. It comprises a motor generator, supplied from the local mains, or a generator driven by an oil engine, which provides the current for the direct-current motors operating the machine. Even if a direct-current supply is available a motor generator is still adopted. The idea of the scheme is, briefly, as follows :—With a steady voltage, either alternating current or direct current, the demands on the supply system will be dependent on the resistance of the shovel, and with an alternating-current system the speed of operation will be independent of that resistance. That is to say, the shovel will work as quickly digging in hard ground as it will do in soft ; but the power demand and the stresses on the machine will be much greater. The Marion generator, however, has a drooping voltage characteristic, so that as the ampères go up, with increasing resistance to the shovel, the volts go down, and the shovel can even be stalled without producing a dangerous rush of current, while so soon as it is out of the cut the motor automatically speeds up and the dumping part of the cycle is carried out as quickly as possible. Incidentally the scheme has the advantage that a simple form of controller can be employed and the operator is saved from a lot of "juggling" to get through hard patches.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	19/- to 21/-
(1) Spanish	19/- to 21/-
(1) N. African	19/- to 21/-
N.E. Coast—	
Native	18/- to 21/-
Foreign (c.i.f.)	22/-

PIG IRON.

	Home. £ s. d	Export. £ s. d.
(2) Scotland—		
Hematite	3 14 0	—
No. 1 Foundry	3 15 0 to 3 16 0	—
No. 3 Foundry	3 10 0 to 3 11 0	—
N.E. Coast—		
Hematite Mixed Nos.	3 10 0	3 10 9
No. 1	3 10 6	3 10 6
Cleveland—		
No. 1	3 8 6	3 8 6
Silicious Iron	3 8 6	3 8 6
No. 3 G.M.B.	3 6 0	3 6 0
No. 4 Foundry	3 5 0	3 5 0
No. 4 Forge	3 4 6	3 4 6
Mottled	3 4 0	3 4 0
White	3 4 0	3 4 0
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	—	—
North Staffs. Forge	—	—
,, ,, Foundry	3 3 6	—
(3) Northampton—		
Foundry No. 3	3 0 0 to 3 1 0	—
Forge	2 14 0	—
(3) Derbyshire—		
No. 3 Foundry	3 4 0 to 3 4 6	—
Forge	2 19 0	—
(3) Lincolnshire—		
No. 3 Foundry	3 4 0	—
No. 4 Forge	3 2 6	—
Basic	3 2 6	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 2 0 (a) / 4 5 0 (b) / 4 8 6 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	10 5 0	10 0 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 5 0	—
Common Bars	10 5 0	—
Best Bars	10 15 0	—
Lancs.—		
Crown Bars	10 0 0	—
Second Quality Bars	9 10 0	—
Hoops	13 0 0	—
S. Yorks.—		
Crown Bars	10 10 0	—
Best Bars	11 0 0	—
Hoops	12 0 0	—
Midlands—		
Crown Bars	9 5 0 to 10 5 0	—
Marked Bars (Staffs.)	12 10 0	—
Nut and Bolt Bars	9 0 0	—
Gas Tube Strip	11 10 0	—

STEEL. (d)

	(6) Home. £ s. d.	(7 Export. £ s. d.
(5) Scotland—		
Boiler Plates	10 10 0	10 10 0
Ship Plates, ¾in. and up	8 7 6	7 12 6
Sections	7 17 6	7 2 6
Steel Sheets, ¼in.	8 12 6	8 15 0
Sheets (Gal. Cor. 24 B.G.)	—	13 7 6

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 7 6	—
Angles	7 17 6	—
Boiler Plates	12 15 0	—
Joists	7 17 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	7 2 6	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	7 10 0 to 10 0 0	—
Manchester—		
Bars (Round)	8 17 6	—
,, (Small Round)	7 12 6	—
Hoops (Baling)	10 5 0	10 0 0
,, (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6	—
,, (Lancs. Boiler)	10 0 0	—
Sheffield—		
Siemens Acid Billets	10 0 0	—
Hard Basic	7 2 6 to 7 12 6	—
Intermediate Basic	7 0 0	—
Soft Basic	6 5 0	—
Hoops	9 10 0 to 10 10 0	—
Soft Wire Rods	7 10 0	—
Midlands—		
Small Rolled Bars	7 7 6 to 8 0 0	—
Billets and Sheet Bars	5 15 0 to 6 0 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	—
Galv. Sheets, f.o.b. L'pool	13 5 0 to 13 7 6	—
Angles	7 17 6	—
Joists	7 17 6	—
Tees	8 17 6	—
Bridge and Tank Plates	8 12 6	—
Boiler Plates	11 0 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	18/- to 18/3
Block Tin (cash)	232 0 0
,, (three months)	232 17 6
Copper (cash)	61 2 6
,, (three months)	61 2 6
Spanish Lead (cash)	19 16 3
,, (three months)	20 5 0
Spelter (cash)	25 0 0
,, (three months)	24 16 3
Manchester—	
Copper, Best Selected Ingots	66 0 0
,, Electrolytic	67 0 0
,, Strong Sheets	92 0 0
,, Tubes (Basis Price), lb.	0 1 1
Brass Tubes (Basis Price), lb.	0 1 0
,, Condenser, lb.	0 1 2
Lead, English	21 7 6
,, Foreign	20 10 0
Spelter	25 2 6
Aluminium (per ton)	£107

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/7¼ per lb.	
Ferro Tungsten	1/3 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£22 15 0	7/6
,, ,, 6 p.c. to 8 p.c. ,,	£22 7 6	7/-
,, ,, 8 p.c. to 10 p.c. ,,	£22 5 0	6/-
,, ,, Specially refined		
,, ,, Max. 2 p.c. carbon	£35 0 0	12/-
,, ,, ,, 1 p.c. carbon	£40 10 0	15/-
,, ,, ,, 0·70 p.c. carbon	£50 0 0	17/-
,, ,, ,, carbon free	1/2 per lb.	
Metallic Chromium	2/11 per lb.	
Ferro Manganese (per ton)	£13 10 0 for home £13 10 0 for export	
,, Silicon, 45 p.c. to 50 p.c.	£12 17 6 scale 5/- per unit	
,, ,, 75 p.c.	£20 10 0 scale 6/- per unit	
,, Vanadium	14/3 per lb.	
,, Molybdenum	4/11 per lb.	
,, Titanium (carbon free)	0/11½ per lb.	
Nickel (per ton)	£172	
Ferro-Cobalt	9/6 per lb.	

FUELS.

SCOTLAND.
(Prices not stable.)

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	13/9
,, ,, Ell	14/6
,, ,, Splint	16/9 to 17/3
,, ,, Trebles	13/6
,, ,, Doubles	12/6
,, ,, Singles	11/-
Ayrshire—	
(f.o.b. Ports)—Steam	13/-
,, ,, Jewel	15/6
,, ,, Trebles	13/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	10/6 to 12/-
Screened Navigation	13/-
Trebles	12/- to 12/3
Doubles	12/-
Singles	11/-
Lothians—	
(f.o.b. Leith)—Best Steam	12/3
Secondary Steam	12/-
Trebles	12/3
Doubles	11/6 to 11/9
Singles	11/3

ENGLAND.

(8) N.W. Coast—	
Steams	24/- to 25/-
Household	37/6 to 50/-
Coke	22/6 to 23/6
Northumberland—	
Best Steams	13/6
Second Steams	11/9 to 12/-
Steam Smalls	10/-
Unscreened	11/9 to 12/-
Household	21/- to 27/-
Durham—	
Best Gas	15/3
Second	13/3 to 13/9
Household	21/- to 27/-
Foundry Coke	18/6 to 19/-
Sheffield—	Inland.
Best Hand-picked Branch	27/6 to 29/6 —
Derbyshire Best Bright House	20/6 to 21/6 —
Best House Coal	19/- to 20/6 —
Screened House Coal	16/- to 17/6 —
,, ,, Nuts	15/- to 16/- —
Yorkshire Hards	14/6 to 15/6 —
Derbyshire Hards	14/- to 15/6 —
Rough Slacks	8/6 to 9/6 —
Nutty Slacks	6/- to 7/- —
Smalls	3/- to 4/6 —
Blast-furnace Coke (Inland) 13/- at ovens	—
Furnace and Foundry Coke (Export), f.o.b.	17/- to 18/-

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	19/3 to 19/6
Second Smokeless Large	18/6 to 19/-
Best Dry Large	18/- to 18/6
Ordinary Dry Large	17/6 to 18/-
Best Black Vein Large	17/- to 17/3
Western Valley Large	16/6 to 16/9
Best Eastern Valley Large	16/6 to 16/9
Ordinary Eastern Valley Large	16/- to 16/3
Best Steam Smalls	12/6 to 13/-
Ordinary Smalls	11/- to 12/6
Washed Nuts	18/- to 23/-
No. 3 Rhondda Large	19/6 to 20/-
,, ,, Smalls	14/- to 14/9
No. 2 ,, Large	16/- to 16/6
,, ,, Through	14/6 to 15/6
,, ,, Smalls	12/6 to 13/6
Foundry Coke (export)	30/- to 37/6
Furnace Coke (export)	27/6 to 30/-
Patent Fuel	21/6 to 23/-
Pitwood (ex ship)	27/6 to 27/9
Swansea—	
Anthracite Coals:	
Best Big Vein Large	30/- to 32/6
Seconds	24/6 to 27/6
Red Vein	20/6 to 25/-
Machine-made Cobbles	38/- to 41/-
Nuts	37/6 to 42/6
Beans	23/- to 27/-
Peas	17/- to 18/-
Breaker Duff	8/- to 8/6
Rubbly Culm	9/6 to 10/-
Steam Coals:	
Large	17/6 to 18/6
Seconds	16/- to 17/-
Smalls	9/9 to 11/-
Cargo Through	15/- to 16/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (a) Delivered Glasgow. (b) Delivered Sheffield, (c) Delivered Birmingham. (d) Rebate 12/6 joists and 10/- all other materials if home consumers confine purchases solely to British products.

French Engineering Notes.

(From our Correspondent in Paris.)

The Steel Union.

At the last meeting of the International Steel Union it was decided to make no change in the steel production during the second quarter of the year, the situation being now sufficiently stabilised both as regards consumption and prices. As, however, there appears to be little likelihood of a further advance in prices, and as the demand has fallen off appreciably in some cases, other matters have arisen which have required adjustment. At a time when the home demand was so great that Germany had to produce more than her quota to supply it, the Union reduced the penalty for an excess production from 4 dollars to 1 dollar per ton on condition that German firms agreed to restrict their exports of steel. They now see that they must again look to foreign markets to absorb a part of their production, and the Union decided to allow Germany to export during the second quarter 150,000 tons a month. This was readily conceded because the French steel producers have been disposing of a greater part of their output on the home market, with the result that smaller quantities have been available for export. Steel producers in Central Europe have also been exceeding their quotas in order to meet home requirements, and as Austria, Hungary, and Czecho-Slovakia complained of the heavy burden imposed on them by the penalties, these were reduced from 4 to 2 dollars a ton, but the participation of those countries in the distribution of the accumulated penalty fund was also reduced by one-half. In the case of Poland nothing has yet been done in the way of admitting that country to the Union.

Tariffs and Engineering.

The new import duties, which have been carried through Parliament hurriedly with a view to the completion of negotiations for commercial treaties, have had the effect of giving more stability to foreign trade and of enabling all branches of the engineering industry to form some judgment of their future position. The main object of the new tariff was to provide the maximum protection for home industries and to offer the widest scope for bargaining with other countries for commercial advantages. In many cases the ultra-protectionist tendency of Parliament was checked by the limitations imposed by the treaty with Germany, since that country would have been entitled to revoke the treaty if the import duties were increased to a point at which they would be considered as practically prohibitive. Nevertheless, in all cases the duties were advanced, but they have permitted the French Government to make notable concessions and to conclude treaties with Belgium and Switzerland, negotiations for which had been held up for a considerable time. Probably, never before have treaties of commerce been subjected to such desperate bargaining. In the case of Belgium, reductions of 20 per cent. have had to be accorded on the tariffs originally proposed by France for engineering products entering this country, and similar concessions have had to be made to Switzerland, without which there would certainly have been an almost complete cessation of trade between France and those countries. Experience of the past few months has shown that there is a limit to the duties that can be imposed on foreign goods. The new tariffs may appear heavy when applied to countries in which production costs are high; but, on the other hand, it is by no means certain that costs in France will not increase before the financial stabilisation process is completed. The importance of the new fiscal policy lies in the fact that the way is being prepared for the resumption of more normal business relations with France, and the extent of the British participation will depend largely upon the advantages that can be secured by the British Government when the time comes for negotiating a treaty of commerce. Despite the remarkable development of the French mechanical engineering industry, there is no reason why British engineering firms should not do a satisfactory business in this market, on condition that prices are not rendered exorbitant by too great a difference in production costs in the two countries.

The Chambon-Romanche Barrage.

The recent communication of Monsieur Mesnager to the Académie des Sciences to the effect that solid barrages are constructed with bases of insufficient thickness and are therefore a constant menace to the public safety, has evidently aroused some feeling of uneasiness, for at the instigation of the Chamber of Commerce of Grenoble Monsieur Haegelen, chief engineer of the hydraulic services, held a conference recently concerning the dam which is to be constructed at Chambon on the Romanche. He declared that there was no ground for the criticism that existing barrages did not provide for exceptional pressures. The Perrégaux barrage in North Africa failed because hydraulic engineers knew nothing at the time it was constructed about the hydraulic conditions of that country. For thirty years there had been no instance of a barrage giving way in France. Monsieur Haegelen then gave details of the Chambon barrage which is to be constructed on the Upper Romanche. It will create a reservoir having a capacity of 50 million cubic metres, and between its level and that at the junction of the Drac and the Isère—a difference of about 800 m.—the total amount of energy available will be 110 million kWh a year. The Chambon barrage will have a height of 88 m. above the bed of the river and its thickness at the base will be 56·25 m. It will be of triangular section, except at the base, where it will form a kind of wedge in a narrow gorge. The sluices are arranged to provide for an emergency discharge up to 400 cubic metres a second, that being necessary to provide for military requirements in the event of the reservoir having to be emptied, and, as it represents five or six times the maximum flow observed during the past twenty years, there can, it is affirmed, be no risk of undue pressure on the barrage. In its construction 250,000 cubic metres of concrete will be employed. The lake thus created will cover 350 acres and will submerge three villages and a part of the road between Grenoble and Briançon.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

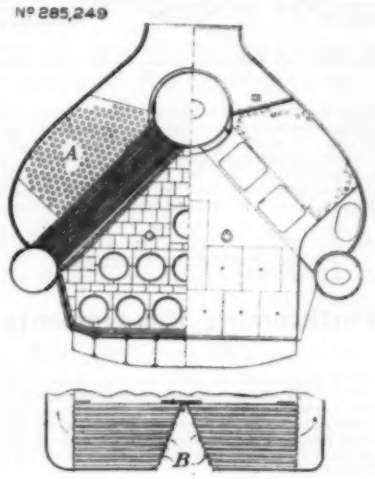
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

285,249. February 14th, 1927.—AIR HEATERS FOR WATER-TUBE BOILERS, J. I. Thornycroft and Co., Ltd., Smith-square, Westminster.

It is claimed that this arrangement of preheater for the air needed for combustion in the furnace of a water tube boiler gives

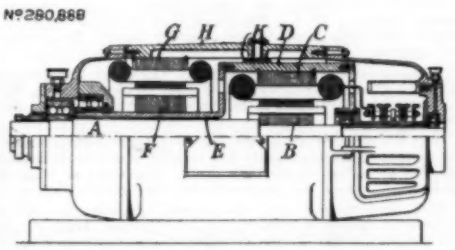


a much greater output than any previous arrangement. The air enters the heating tubes A by the wedge-shaped opening between the tube plates B B and travels in both directions towards the furnace.—*February 15th*, 1928.

DYNAMOS AND MOTORS.

280,888. October 29th, 1927.—IMPROVEMENTS IN OR RELATING TO ELECTRIC MOTORS, Adolf Baier, Birsfelden, near Basle, Switzerland.

This specification describes a small motor for driving machine tools. Two motor units are arranged in the same casing. The rotor of one unit is fixed to the shaft and its field magnets are rotably mounted on the shaft. The shaft A is coupled directly to the machine tool. It carries a rotor B, the field magnet C of which is fixed to the inside of the drum D, which is free to

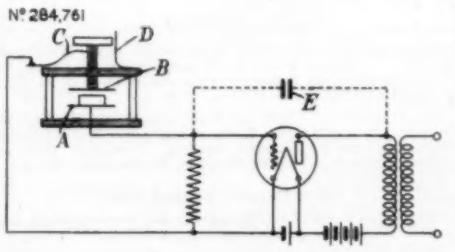


rotate about the shaft A and is provided with an offset hub E for the rotor F of the second motor unit. The field magnet G of the latter is fixed to the inside of the casing, whilst the rotor F is mounted on the hub E. The inventor claims that owing to the arrangement of the two units there is a saving in space in a radial direction and that the arrangement is capable of giving economical speed variation. At K there is a brake which acts on the drum D.—*February 16th*, 1928.

TELEGRAPHS AND TELEPHONES.

284,761. November 2nd, 1926.—IMPROVEMENTS RELATING TO PIEZO-ELECTRIC DEVICES, Standard Telephones and Cables, Ltd., of Connaught House, Aldwych, London, W.C. 2.

This invention relates to the use of piezo-electric devices in electrical transmission systems. These devices comprise crystals

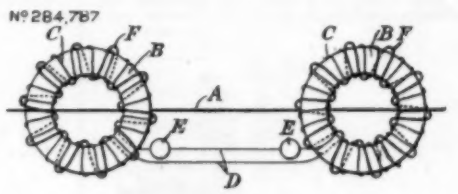


vibrating between two conductive plates and are usually cut from a substance such as quartz. As the size of the air gap between the crystal and one of the conducting plates is changed the frequency of vibration of the piezo-electric crystal also changes, and this will cause a corresponding change in the frequency of the alternating current generated by a space discharge tube oscillator controlled by the crystal or in the frequency of the current which is absorbed by the crystal if it is used as an absorption element. The diagram shows an arrangement for changing the frequency of an oscillator. It will be seen that the grid of the valve is connected to a plate A which supports the piezo crystal, whilst another plate B connected to the cathode can be adjusted by means of a thumb screw and a terminal C. The device is placed in a box made of hard rubber, bakelite or other dielectric material. A graduated scale is provided at D so that the displacement of the screw may be determined. The valve is provided with the usual batteries and a resistance to maintain the grid at a suitable negative potential. The condenser E represents the inherent capacity between the grid and the anode, and it is this capacity which produces a reaction of the plate circuit on the grid circuit to produce sustained oscillations. The piezo-electric crystal varies and controls the frequency of oscillations generated by the valve. In order to reduce the effects of outside influences, such as varying temperature or humidity, the plates and the crystal may be mounted in a vacuum tube.—*February 2nd*, 1928.

TRANSMISSION OF POWER.

284,787. November 6th, 1926.—IMPROVEMENTS IN OR RELATING TO ELECTRIC PROTECTIVE SYSTEMS, A. Reyrolle and Co., Ltd., of Hebburn-on-Tyne, and Thomas Reginald Warren, of 7, Dene-gardens, Station-road, Pelaw-on-Tyne.

In protective systems difficulty has arisen owing to the inadvertent operation of the relays or other tripping devices in the pilot circuit owing to surges of high-frequency currents flowing in the protected conductor as a result, for example, of faults on other parts of the network. The trouble is believed to be due either to the earth capacity of the protected feeder, or to the earth capacity of the pilot wires, as a result of which the high-frequency E.M.F. induced in the transformer secondary windings gives rise to a capacity current sufficient to operate the relays. In the arrangement illustrated, the conductor A to be protected is passed through the iron core B of a protective current transformer of

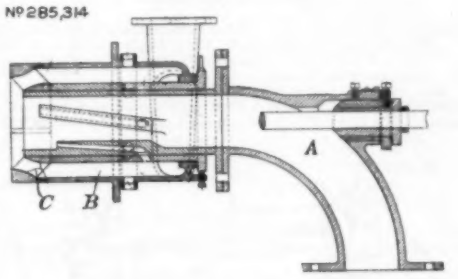


the ring core type at each end. Each transformer core B is wound with an evenly distributed secondary winding C, and the two secondary windings are connected to the pilot circuit D, which is provided in the usual manner with a tripping relay E at each end, the arrangement being such that the induced E.M.F. in the two secondary windings C normally balance one another in the pilot circuit. Each transformer core B is also wound with an evenly distributed third winding F, which is short circuited. In some cases it may be possible to employ a metallic sheath of resistance material in place of the third winding. Although having little effect on the secondary E.M.F. at normal frequency, the short-circuited winding has a very large effect at high frequencies, and the risk of inadvertent operation of the tripping relays on the occurrence of high-frequency surges in the primary circuit is reduced to a minimum.—*February 6th*, 1928.

FURNACES.

285,314. July 22nd, 1927.—BURNERS FOR PULVERISED FUEL, H. A. Marston, The Rosary, Benhill-avenue, Sutton, Surrey.

In this burner the fuel delivery pipe A terminates within a jacket B, which is supplied with air or steam under pressure. The outlets from this jacket are formed by axoid webs C. On account of the curved form of these ports the air emerging from the jacket will in part be caused to follow an inward direction



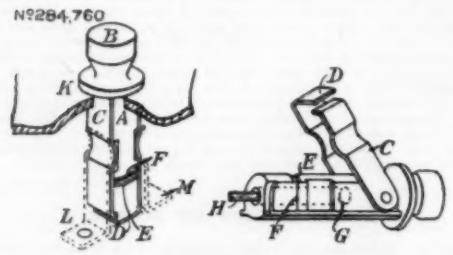
of travel and tend to reduce the velocity of the fuel issuing from the burner, while part will be caused to take an outward direction, and, impinging on the fuel discharged from the burner, will tend to open up the fuel formation as directed by the burner. Further, as the ports do not correspond axially the fuel velocity will be retarded owing to the varying influence of the air emerging from them.—*February 16th*, 1928.

LIGHTING AND HEATING.

284,760. November 2nd, 1926.—IMPROVEMENTS IN AND RELATING TO ELECTRIC FUSE HOLDERS, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, W.C. 2, and Albert George Salisbury, of "Dovedale," Priory-road, Kenilworth, Warwickshire, and Thomas Henry Woodfield, of 85, Addison-road, King's Heath, Birmingham.

This invention relates to devices for holding fuses for protecting electric circuits from overloads, and more particularly to fuse holders for use on motor vehicles to protect the lighting circuit. A represents a stem of insulating material, having a handle B. The stem A may be substantially cylindrical in cross section with flattened portions on opposite sides. Pivoted to these flattened portions in proximity to the handle B are two conducting strips or pole pieces C D, which normally lie against the flattened portions, as shown on the left. A shallow groove E is formed in the stem A on one side, extending from one flattened portion to the other, and in this groove a fuse wire F is held in place by means of the pole pieces C D, the diameter of the stem being such that the wire between the edges of the pole pieces has the correct length to protect the circuit. The stem A is provided with a central longitudinal chamber G, extending from the end remote from the handle inwards for

a distance sufficient to accommodate spare fuse wires H cut to the required length. In order to close the chamber G and prevent the fuse wire from falling out, the pivoted pole piece D is extended, and bent so that it normally covers the aperture of the chamber. The cross section of the stem A and pole pieces C D is substantially the same as that of the aperture on the switchboard K through which it is inserted. The pole pieces

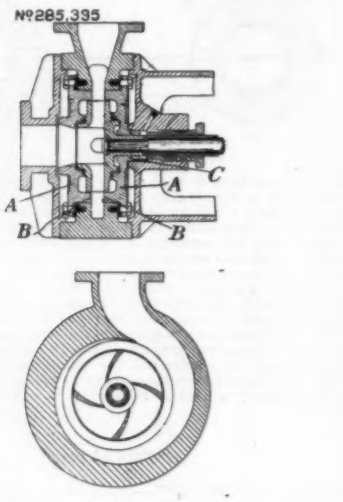


C D make contact with slips L M, which are attached to terminals on the switchboard. To insert a new fuse, it is only necessary to withdraw the stem A, rotate the pole pieces C D about their pivots, lay a new fuse wire in the groove E in the stem A, and bring the pole pieces back to their normal positions. The pole pieces C D then make contact with the ends of the wire F and press it against the flattened sides of the stem.—*February 2nd*, 1928.

PUMPING AND BLOWING MACHINERY.

285,335. September 13th, 1927.—CENTRIFUGAL PUMPS, E. N. Mackley, Hawkes-road, Gateshead.

This pump is intended for handling liquids containing abrasive materials, such as gravel or clinker, and is characterised

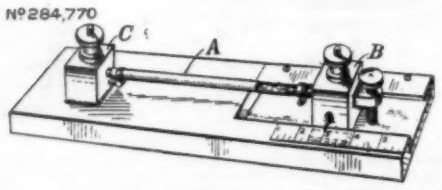


by the fact that the impeller is embraced by renewable liners A A. These liners are of cast iron with the faces B B chilled, and that on the inner side is extended, as shown at C, to form a bearing for the impeller boss.—*February 16th*, 1928.

MISCELLANEOUS.

284,770. November 3rd, 1926.—IMPROVEMENTS IN VARIABLE ELECTRICAL RESISTANCES, John Logie Baird and Television, Ltd., both of Motograph House, Upper St. Martin's-lane, London, W.C. 2.

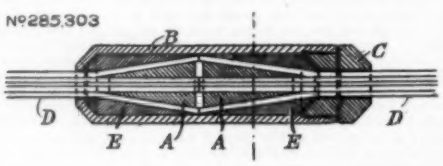
The variable high-resistance described in this specification consists of a rubber tube A filled with liquid, such as distilled water. The block B to which one end of the tube is attached is



adjustable, whilst the block C is fixed. It will be understood that when the tube is stretched lengthwise, it also contracts laterally, so that the continuity of the water is not impaired. The resistance varies as the length and also inversely as the cross-sectional area, and as the volume of the water is constant within the range of pressure to which it is subjected, the resistance varies as the square of the length of the tube, and a considerable range is thereby easily secured.—*February 3rd*, 1928.

285,303. June 23rd, 1927.—IMPROVEMENTS IN OR RELATING TO COUPLINGS FOR ELECTRIC CONDUCTORS, Johannes Wilhelm Hofmann, of Kötzschenbroda, near Dresden, Germany.

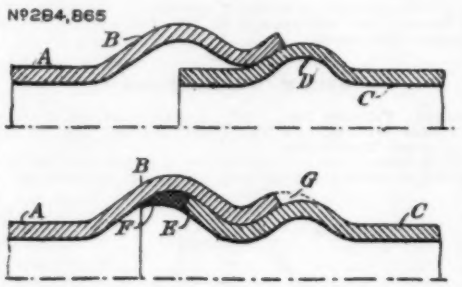
The coupling described in this specification is mainly intended



for electric cables that are subjected to considerable tensile stress. As shown in the drawing, the ends of the cables D are held by conical members A and E which are enclosed in a shell B. One end of this shell is screwed for the reception of a cap which forces the coned parts into contact with the ends of the cables and forms a rigid joint.—*February 16th*, 1928.

284,865. February 14th, 1927.—IMPROVEMENTS IN OR RELATING TO CONNECTING MEANS FOR TUBES, Mannesmannröhren-Werke, of Berger Ufer 1B, Düsseldorf, Germany, and Carl Platte, of Gustav Poensgenstrasse 25, Düsseldorf, Germany.

This invention relates to a method of connecting tubes. In autogenous or electrical welding of tubes, expansions and stresses are produced in the material, and the object of this invention is



to overcome this trouble. According to the invention, the tubes have corrugated ends and the welding serves primarily as a fluid-tight packing. The tube A is corrugated and widened out to form a sleeve B, and the other tube C is provided with an annular corrugation D. The end E is subsequently bent in the manner shown in the lower drawing, and the joint is made tight by welding at F or G, or at both these places.—*February 9th*, 1928.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, London, S.W. 1. Informal meeting. Discussion on "Mechanical Handling of Goods," introduced by Mr. J. H. Walker. 7 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Council House, Birmingham. West Midland District meeting. Lecture, "Birmingham's Elan Water Supply," with lantern slides, by Mr. F. W. Macaulay, M. Inst. C.E. 5.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria street, S.W. 1. Informal meeting. "High-tension and Low-tension Supply for Wireless Receivers from Electric Mains," by Mr. B. J. Axton. 7.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Informal meeting in the Institution Library. Subject for discussion, "The Steering of Ships," to be introduced by Mr. H. G. Williams, Vice-President. 7.15 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "A Physical Chemist in Search of Purity in an Impure World," by Dr. Ernst Cohen. 9 p.m.

SOCIETY OF CHEMICAL INDUSTRY: CHEMICAL ENGINEERING GROUP.—Chemical Society, Burlington House, London, W. 1. "Ultra-violet Radiation in Industry," by Mr. Alfred A. King. 8 p.m.

THE INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—A meeting of the Institution will be held in the South Midland District at Luton, at eleven o'clock. Inspection of municipal works.

THE INSTITUTION OF PRODUCTION ENGINEERS.—At the Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W. 1. Mr. R. H. Hutchinson will introduce a debate on "Plant Maintenance," including the general maintenance of machine tools. 7.30 p.m.

SATURDAY, MARCH 24TH.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "The Transformation of Matter," by Sir Ernest Rutherford. 3 p.m.

MONDAY, MARCH 26TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, London, S.W. 1. Graduates' Section meeting. Annual lecture, "The Trend of Modern Steam Locomotive Design," by Mr. R. E. L. Maunsell. 6.30 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS.—Park-lane Hotel, London, W. 1. Annual dinner. 6.30 p.m. for 7 p.m.

THE INSTITUTION OF ELECTRICAL ENGINEERS: NORTH-EASTERN CENTRE.—Armstrong College, Newcastle-on-Tyne. "Practice and Progress in Combustion of Coal as Applied to Steam Generation," by F. H. Rosencrant. Mr. T. S. Blenkinsop will read the paper. 7 p.m.

TUESDAY, MARCH 27TH.

SHEFFIELD METALLURGICAL ASSOCIATION.—198, West-street, Sheffield. "Melting Steel by High-frequency Currents," by W. S. Gifford. This paper will be the joint work of Mr. D. F. Campbell and Mr. W. S. Gifford. 7.30 p.m.

THE INSTITUTION OF PRODUCTION ENGINEERS: BIRMINGHAM BRANCH.—In the Windsor Room of the Grand Hotel, Colmore-row, Birmingham. General meeting. "General Principles of Mass Production," by Professor F. W. Burstall. 7 p.m.

WEDNESDAY, MARCH 28TH.

CREMATION SOCIETY OF ENGLAND.—28, Portland-place, London, W. 1. Annual general meeting. 3.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Bolbec Hall, Newcastle-upon-Tyne. Graduate Section. "Modern Mould Loft Practice," by J. C. Stewart. 7.15 p.m.

THE INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Students' informal meeting. Subject for discussion, "The Limitation of Concrete as a Material in Construction," by Mr. R. F. Legget. 6.30 p.m.

WEDNESDAY, MARCH 28TH, TO FRIDAY, MARCH 30TH.

INSTITUTION OF NAVAL ARCHITECTS.—Spring Meetings. Royal Society of Arts, John-street, Adelphi, W.C. 2. For programme see page 302. Annual Dinner, Wednesday, March 28th, Connaught Rooms, Great Queen-street, London. 7.30 p.m.

THURSDAY, MARCH 29TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, S.W. 1. "The Electrification of the Pietermaritzburg-Glencoe Section of the South African Railways," by F. Lydall. 6 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS (LONDON).—Denison House, 296, Vauxhall Bridge-road, London, S.W. 1. "Engine Failures," by Mr. J. Clayton. 6 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "The Physiological Aspects of Flying," by Captain Martin Flack. 5.15 p.m.

FRIDAY, MARCH 30TH.

DIESEL ENGINE USERS ASSOCIATION.—19, Cadogan Gardens, London, S.W. 3. "Liquid Fuel from Coal," by D. Brownlie.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH-EASTERN STUDENTS' SECTION.—Lighting Service Bureau. Dial House, Northumberland-street, Newcastle-on-Tyne. Annual general meeting. 7.15 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, London, S.W. 1. Informal meeting. A discussion on "The Problem of Utilising the Earth's Internal Heat" will be opened by Mr. J. L. Hodgson. 7 p.m.

INSTITUTION OF WELDING ENGINEERS.—Caxton Hall, Westminster, London, S.W. 1. "Bronze Welding," by Mr. W. Steele. 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Informal meeting. "Locomotive Maintenance," by Mr. C. F. Adams. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "Radio-active Atoms and their Structure," by Sir Ernest Rutherford. 9 p.m.

THE INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—In the Non-ferrous Section of the Applied Science Department of the University, St. George's-square. "Non-ferrous Metals in Relation to Ferrous Metallurgy," by Dr. W. H. Hatfield. 7.30 p.m.

THE INSTITUTION OF LOCOMOTIVE ENGINEERS (LONDON): MANCHESTER CENTRE.—In the College of Technology, Sackville street, Manchester. "Some Features of the Mechanical and Electrical Equipment of the Port of Manchester," illustrated by lantern slides, by Mr. W. G. Smith. 7 p.m.

SATURDAY, MARCH 31ST.

BOROUGH POLYTECHNIC INSTITUTE.—Borough-road, S.E. 1. Annual exhibition of students' work. 2.30 to 9.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—Visit to the stained glass studios of James Powell and Son (Whitefriars), Ltd., at 98, Wigmore-street, W. 1. 2 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "The Transformation of Matter," by Sir Ernest Rutherford. 3 p.m.

TUESDAY, APRIL 3RD.

INSTITUTION OF AUTOMOBILE ENGINEERS.—At the house of the Royal Society of Arts, John-street, Adelphi, London, W.C. 2. General meeting. 7.45 p.m.

FRIDAY TO MONDAY, APRIL 6TH TO 9TH.

THE INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Southern District meeting in Guernsey.

THURSDAY, APRIL 19TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. The Nineteenth Kelvin Lecture, "Recent Advances in Physics," by Sir Oliver Lodge. 6 p.m.

THE INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—Prince's Chambers, 6, Corporation-street, Birmingham. Annual general meeting. "The Sandfields Filters of the South Staffordshire Waterworks Company," by Mr. R. A. Robertson.

THURSDAY, MAY 3RD.

IRON AND STEEL INSTITUTE.—Connaught Rooms, Great Queen-street, London, W.C. 2. Annual dinner. 7 for 7.30 p.m.

THURSDAY AND FRIDAY, MAY 3RD AND 4TH.

IRON AND STEEL INSTITUTE.—At the house of the Institution of Civil Engineers, Great George-street, London, S.W. 1. Annual meeting.

CONTRACTS.

YARROW AND CO., Ltd., Scotstoun, Glasgow, inform us that the War Office has accepted their offer for the installation of the latest type of Yarrow water-tube boilers at the power station at Woolwich Arsenal.

IN addition to the contracts secured by the "De Maas" Shipbuilding Company, of Slikkerveer, Holland, mentioned in our issue of March 9th, the firm has secured a further contract for the construction of six motor ships, measuring 165ft. by 28ft. 8in. by 10ft., to be fitted with Sulzer Diesel engines.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. B. D. F. DOCKER has been elected a director and deputy chairman of the Metropolitan-Vickers Electrical Company, Ltd.

AN agreement has been entered into between Automatic and Electric Furnaces, Ltd., and Alfred Herbert, Ltd., of Coventry, for the sale of Wild-Barfield furnaces in Scotland.

THE STILL ENGINE COMPANY, Ltd., informs us that on and after March 25th, 1928, its address will be 10, Victoria-street, Westminster, London, S.W. 1 (telephone number, Victoria 1988).

IN connection with the recent formation of Kryn and Lahy (1928), Ltd., steel founders and engineers, Letchworth, Herts, we are asked to state that Messrs. R. P. Abel and J. Deschamps have been appointed general managers and directors.

BROUGHTON COPPER WORKS (1928), Ltd., Manchester, has taken over the business and works of the Broughton Copper Company Ltd. The company will complete all the pending contracts of the old company and discharge its accounts. All the directors of the new company have for many years past been intimately connected in the actual administration of the old company.